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ROENTGEN IRRADIATION OF THE PELVIS IN CARCINOMA OF THE CERVIX UTERI¹

OUR PRESENT METHOD

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THE usual discussion of cancer therapy primarily presents results, and only secondarily describes the method of treatment. It is generally agreed that at least five years should elapse before such a report is made. The methods of treatment described, therefore, are usually those employed five years before. To know just how other therapists actually manage their patients at the present time, we must visit their treatment rooms. Rather than offering results in this paper, we shall set forth the details of our present manner of treatment, together with our reasons for adopting the technic now in use.

In treating a patient with cancer the object is to restore the patient's health by eradicating the neoplasm. This requires knowledge not only of the site of the primary lesion but also of the location of all of the structures to which it may spread. At the University of California Hospital, patients with uterine cervical cancer are treated jointly by gynecologists and roentgenologists. Those suspected of having the disease are placed in the hospital for a complete investigation, including history,

physical examination, basal metabolism test, photographs, artist's drawings of the lesion, and a biopsy. If there is clinical evidence of ureteral obstruction, intravenous urography is included in the study. Because of the cost of this procedure, it has not been done routinely, although it is probable that the information to be gained more than repays the expense. Many of the earlier investigators, Wagner, Winter, and Williams, among others mentioned by Morton, and Morton (1) himself, found that extensive renal disease was present in almost every patient on whom an autopsy was performed and observed that the patient with cervical cancer usually died as a result of ureteral blockage rather than of cancer *per se*. The clinical picture of ureteral compression is varied. The findings may include pain in the flank, symptoms of pelvic pressure, sciatica, or weakness of the leg, or the only presenting evidence may be that of a hidden infection—loss of weight, anemia, anorexia, and fever. Even though the original urograms are negative, they may be of decided value later, when a ureteral block has developed. The earlier pyelograms will permit a more accurate decision concerning the progress of the disease. Furthermore, ureteral blockage with hydro-

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nephrosis and subclinical uremia may be responsible in the individual case for the immediate untoward response to x-ray therapy. The introduction of a ureteral catheter may alleviate the symptoms promptly, permitting the completion of the full course of treatment.

If the lesion in the cervix is small and well localized, the first treatment with radium is given immediately after the biopsy and the complete course of radium therapy is carried out as described below. If the growth has been classified as of Stage I or early Stage II (Schmitz) and the patient is a good operative risk, a Wertheim operation is then performed. Otherwise, a course of x-ray therapy follows the radium therapy.

If, however, the growth is bulky and extensive, the course of x-ray treatments is given first. This is followed in from two to six weeks, according to the condition of the patient, by radium therapy. The purpose of using the x-rays first is to decrease the size of the lesion so that the radium can be applied more effectively. It is not our intention to discuss radium therapy in any detail. Morton (2), on Lynch's service at the University of California Hospital, summarized it as follows:

"The aim is to give a total of 4500 mch.—2000 mch. in the cervical canal proper, 1000 mch. in the fundus, and 1500 mch. against the cervix. This may be supplemented according to circumstances. Often tubes are placed in the lateral vaginal fornices, or needles are inserted into the para-cervical tissues. In some instances the patient receives as much as 7000 to 8000 mch. Usually the desired dose is arrived at in three sittings, a week apart. For the intra-cervical and intra-uterine applications the screening is gold 0.5 mm. and rubber 2 mm. A tandem of three radium capsules in rubber tubing is used. For the vaginal applications, the screen is platinum 0.5 mm., brass 2.0 mm. Various plaques, boxes and tubes are used."

In our plan of management, the radium therapy is considered as the principal method of treatment of the primary lesion. The beam of roentgen rays is not aimed at the cervix, but at the probable regions of

extension and metastasis. The location and size of the fields to be used and the direction of the beam depend, therefore, on the location of those structures beyond the reach of the gamma rays which are likely to be involved, namely the lymph channels, lymph nodes, parametrium, and vagina.

There are numerous anatomical descriptions of the lymph channels leading from the cervix uteri to the primary and secondary lymph nodes, but few of them are so presented as to make readily available the relations of these structures to surface landmarks, nor is indication given as to those not likely to be involved by carcinomatous metastases. Lynch (3) thoroughly reviewed them with reference to the spread of cervical cancer and more recently Rouvière (4) also described them.

The conclusions of these authorities may be epitomized as follows: There are from 5 to 8 lymph channels from the region of the cervix. These are grouped into three sets: (1) First are those that drain laterally, and slightly anteriorly, to the iliac nodes lying adjacent to the external iliac artery. The lowest of these nodes lies on the anterior surface of the obturator nerve, usually well above the obturator canal, and is known as the obturator node. (2) The second group is comprised of those that drain postero-laterally to the hypogastric lymph nodes on the hypogastric (internal iliac) artery near the bifurcation of the iliac arteries. (3) Those of the third group drain posteriorly over the posterior vaginal fornix through the utero-sacral ligaments. They pass around the rectum to the sacral nodes that lie beside the sacral ganglia or near the midline beneath the sacral promontory.

From the primary nodes, channels lead to the lumbar nodes lying near the midline just below the bifurcation of the aorta, and therefore on the anterior surface of the fourth and fifth lumbar vertebrae. Further extensions from these pass upward along the aorta. At times there is a direct channel from the cervix to the lumbar nodes, but apparently this pathway is

seldom followed by carcinomatous metastases. There are also secondary channels from the iliac nodes to the inguinal nodes, which are, however, rarely involved.

Several lesser lymph nodes are found in the parametrium. A fairly large one, called the ureteral or Championnier node, is frequently located near the point at which the uterine artery crosses the ureter. When disease is present in the cervix,

ever, does not indicate where metastases are most likely to be found. This information is found in reports from the operating table and the autopsy room. Taussig (5), after a study of the literature, summarized his findings, which we quote below. The groups to which he refers are those of the League of Nations classification.

"1. Cancer is found in from 25 to 33 per cent of lymph glands removed in Group I

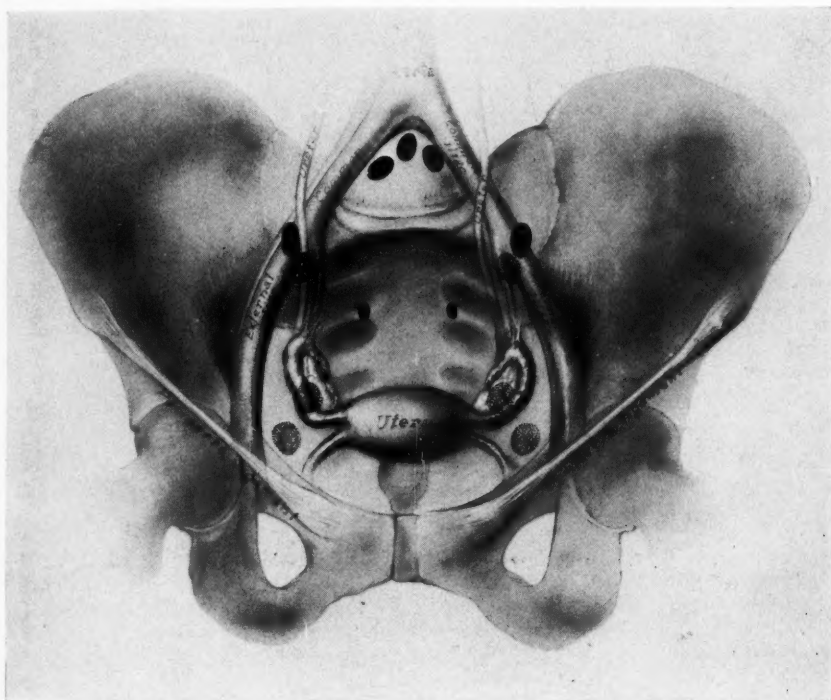


Fig. 1. Drawing showing position of the main lymph nodes draining the cervix uteri. The dotted ones lie behind the structures shown. The center of vision for this diagram is the same as the focal spot of an x-ray tube placed for pelvic treatment at 80 cm. distance.

atypical nodes apparently develop in the walls of the main lymphatic channels.

It is well to remember that none of these channels passes through the free portion of the broad ligament, nor are any of the nodes located there. Both the lymph channels and nodes draining the cervix are in the relatively fixed structures of the pelvis and consequently do not move about as the patient is placed in various positions.

The *anatomy* of the lymphatics, how-

operable cases, in from 45 to 50 per cent of lymph glands removed in advanced (Groups II or Group III) cases, in about 66 per cent (two-thirds) of the cases coming to autopsy (Group IV).

"2. Considerable uniformity is manifest in the anatomic spread of lymph gland metastasis. Where lymph gland cancer is present, it is limited in about 95 per cent of the cases to the so-called Stage I glands, meaning thereby the iliac triangle or hypogastric glands, the obturator glands, the ureteral or Championnier glands, and the sacral glands. In order

of frequency these glands are involved: (1) iliac, (2) obturator, (3) ureteral, (4) sacral. Stage II glands include the lumbar aortic glands, the inguinal glands, and the glands over the common iliac vessels. These Stage II glands are involved in addition to Stage I glands in Group I and Group II cervical cancer in from 5 to 10 per cent of the cases but practically never are involved as a primary metastasis without any cancer in Stage I glands.

"3. It seems a fairly constant rule that Stage 2 glands become involved only as an

Lynch (3) stated that in from 10 to 20 per cent of patients with early small lesions lymph nodes are involved without involvement of the parametrium.

Schauta's (6) autopsy studies showed that 43.3 per cent of subjects with advanced uterine carcinoma had involvement of lymph nodes beyond the pelvis. Morton (1) studied the autopsy material of 36 patients who had been irradiated.



Fig. 2. Roentgenogram of injected arteries, showing the level of bifurcation of the common iliac arteries. Loaned by Dr. Ole A. Nelson of Seattle.

overflow after the cancer has filled up glands of Stage I distribution.

"4. Enlarged, indurated glands do not necessarily mean cancer metastasis, nor do small soft glands exclude such a possibility. Microscopic section is required to establish a positive diagnosis.

"5. While glands are most apt to be involved if the parametrium is infiltrated, it may happen that glands are involved without cancer in the parametrium and the parametrium may be extensively invaded without gland metastasis."

Metastasis had occurred in 16, and in most of these some metastases were present beyond the pelvis.

The foregoing studies show that it is impossible to tell from any physical examination whether the lymph nodes are involved. Up to 50 per cent of those patients whom various surgeons considered as operable had involvement of lymph nodes. Any plan of therapy, therefore, must include, as a minimum, a thorough

irradiation of all the regions where the primary lymph nodes lie. In patients with very advanced disease we must bear in mind that about 50 per cent will have involvement of the secondary nodes, which are outside of the true pelvis. Figure 1 shows our conception of where these various nodes lie, as viewed from the position occupied by the x-ray tube during treatment.

The lowest (most caudad) primary node is the obturator. Taussig (5) described it as lying halfway between the bifurcation of the common iliac artery and the femoral ring, but in his diagram (7) he portrayed the involved tissue as extending down to the ring. To include this area well in from the edge of the field requires irradiation of an area which extends to below the upper border of the pubic bone. The most lateral group of nodes is the iliac, which may extend to the lateral surface of the external iliac artery at a point well below the bifurcation of the common iliac. Relative to the bony structures, this region may be directly anterior to, or just lateral to, the lateral edge of the pelvic inlet (brim of the true pelvis). This is from 6 to 7 cm. lateral to the mid-sagittal plane.

The highest (most cephalad) extension of the iliac group of nodes appears to be the point of bifurcation of the common iliac arteries (Fig. 1). Taussig stated that a node found at this point is the most common site of metastasis. Textbooks in anatomy usually show this bifurcation at the level of the pelvic brim, lateral to the sacral promontory. X-ray studies (Fig. 2) of these arteries injected *in vivo* with radiopaque material show the level of the bifurcation as varying in different persons. It may even be above the pelvic brim on the anterior surface of the sacrum. Since the node at the bifurcation is the one most frequently involved and therefore should be well within the region of irradiation, the fields selected should be such as to reach to a level at least 2 cm. above the sacral promontory.

The lumbar group of nodes, lying on the anterior surface of the fourth and fifth

lumbar vertebrae just below the bifurcation of the aorta, belong to the secondary nodes. They are involved in only 5 to 10 per cent of cases in Groups I and II (League of Nations classification). To include them would require a considerable upward extension of the field of irradiation. Much more of the intestines would be irradiated, and the general and local reactions of the patient would be more

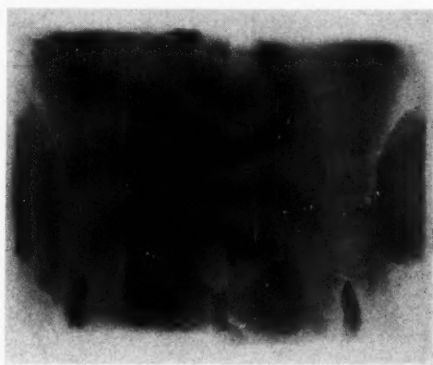


Fig. 3. Roentgenograms of both treatment fields on the same film. A cotton plug soaked in barium lies in the vaginal vault, showing that all the paracervical area and the upper two thirds of the vagina are included. A comparison with Figure 1 shows that all primary nodes are included. The dark streak down the center is the crossing of the fields.

severe, requiring a reduction in the rate of administration and the total amount of radiation. Consequently this region is included only in advanced cases.

Anteriorly the iliac group of nodes may lie on the anterior surface of the external iliac artery, which is well behind the plane of the posterior surface of the symphysis pubis. Posteriorly the sacral nodes lie almost against the anterior surface of the sacrum. These positions must be borne in mind in the treatment of lateral fields.

In addition to the spread of the cancer through the lymph channels and nodes, there may be direct extension into the walls of the vagina and, less frequently, metastatic spread down the lymphatic plexus into the walls of the vagina. These areas should not be left wholly to the effects of the local radium treatments. No satis-

factory statistics were found on the frequency of extension of cancer of the cervix to portions of the vagina below the upper third, if such extension or metastases are not present when the patient first presents herself. Lynch (8) and his co-workers gave as their clinical (not statistical) impression that such spread is very infrequent. To include the entire vagina in the irradiated area necessitates the inclusion of the vulva. This results in a severe local reaction, which should be avoided if possible with-

of the lesion is usually made by both the examiner and the medical artist. Unless the patient is bleeding at the time she comes to us, an additional examination is made to determine the extent of the disease, the position of the cervix relative to the anterior surface of the body, and the extent of vaginal involvement. Next the fields to be used are laid out. Routinely two fields anteriorly and two posteriorly are employed. When the patient is more than 20 cm. in thickness, right and left

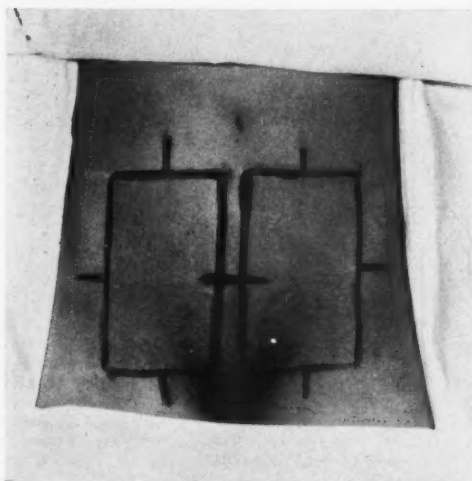


Fig. 4. Anterior fields marked out for treatment. Compare this with Figure 3 to see structures irradiated.

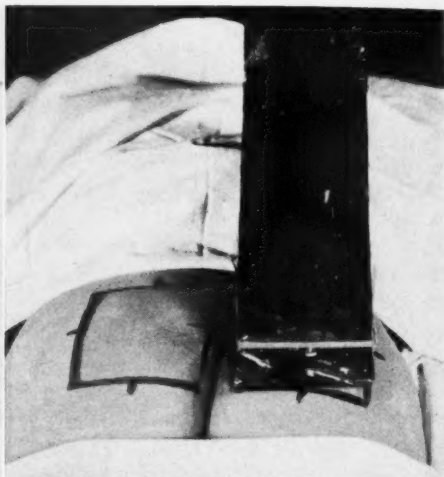


Fig. 5. The markings of the posterior fields for treatment and the angle of the cone of the 200 kv. unit.

out jeopardizing the patient's future. Film studies, made with the x-ray tube centered as it would be for therapy (Fig. 3) and with lipiodol in the vaginal vault, show that all of the paracervical portion usually lies above the plane of the top of the symphysis pubis. By including all of the symphysis pubis within the field of treatment, at least half of the vagina will be well irradiated. We consider this sufficient.

Such are the general considerations. How do they influence therapy in each individual case? When a patient is referred for treatment the gynecologist's description of his findings is studied carefully. He has made a thorough examination at the time the biopsy was taken and a drawing

lateral fields are usually added. For the past two years a series of observations on skin reactions (9) have been made and lateral fields have been avoided because of the possibility of overlapping the areas of skin under investigation. To compensate for this, larger doses have been delivered to the other fields. A strip at least 2 cm. wide is left down the mid-line anteriorly and posteriorly. This method not only protects the trigone of the bladder, part of the rectum, and the intergluteal folds, but also leaves a strip of normal skin to aid healing. As already emphasized, the main dose is delivered to the parametrium and lymphatic drainage bed rather than to the cervix and mid-line structures.

With the abdomen uncovered the fields are marked out to cover the structures to which cervical cancer is most likely to spread (Figs. 3 and 4). The inferior or caudal margin is placed at the level of the upper limit of the vulva. The upper half of the vagina, the obturator canals (not foramina), and the lower iliac nodes are then well within the edge of the field (compare Figs. 1 and 4). Quimby and Arneson (10) advocated the middle of the symphysis as the lower limit. In our opinion this point is hard to locate and, moreover, may not include enough of the vagina in the field of irradiation, especially if the perineum has a steep slope.

The fields are almost always 10 cm. in width. Since the medial edge is 1 cm. from the mid-line, the lateral edge is 11 cm. from it. This places the lateral edge well beyond the outer edge of the brim of the true pelvis and therefore beyond the most lateral iliac nodes. Moreover, the mid-plane of the beam will be 6 cm. from the mid-line and consequently almost directly over the hypogastric node, which is the one most frequently involved.

The length of the field is determined after a careful study of the configuration of the patient. To irradiate above the uppermost iliac nodes requires extension of the area above the level of the promontory of the sacrum. The location of the promontory with reference to the surface is not easy to determine. Arneson and Quimby (10) used the crests of the iliac bones as the upper limit. Probably this is usually a little higher than is necessary. As a rule, a line 2 cm. below the iliac crests may serve as an upper limit. The fields used by us were most frequently 15 cm. in length, but a check of this with films made on the therapy machine in the position for treatment showed that 15 cm. is often not long enough. All fields should be checked with films, made with the therapy apparatus, of the regions to be treated.

If the patient has Stage IV (Schmitz) cancer of the cervix, it is necessary to include the lower two lumbar vertebrae as well, in order to reach the lumbar nodes.

This will necessitate a field at least 20 cm. in length.

The posterior fields are mapped out to lie directly opposite the anterior fields when the patient is lying in the position in which she is to be treated. The lower limit is usually about 2 cm. below the tip of the coccyx, but this latter structure varies so much that it is not a safe landmark. The upper limit is about 2 cm. below the iliac crest (Fig. 5).

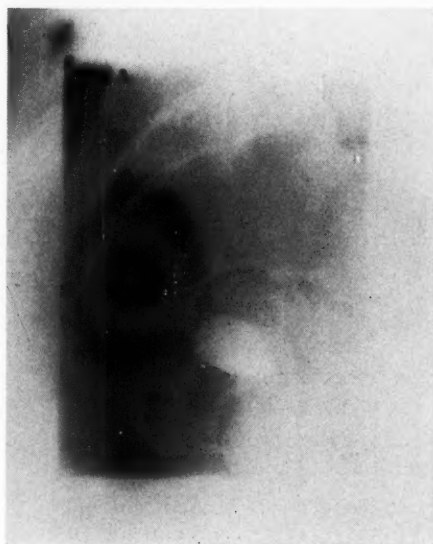


Fig. 6. Roentgenogram made on the therapy apparatus in a lateral position. A cotton plug soaked in barium lies in the vaginal vault. All of the lymph nodes are included in the region so irradiated.

When lateral fields are to be used they are mapped out with the patient lying in the position in which she is to be treated, either on her back with the beam horizontal or on her side with the beam vertical. These fields must be so located that there will be no spraying of radiation to the other fields. It is to be remembered that we are not aiming at the cervix but at the lateral walls of the true pelvis and the anterior surface of the sacrum. It would be desirable to angle the field so that the long edge would parallel the slope of the anterior surface of the sacrum, but this position causes an overlapping of the upper

part of the anterior fields. Each patient must be considered individually. Checking by films will show what structures are being included (Fig. 6).

Many methods have been tried to mark the skin so that the fields will be clearly outlined and will remain so. A mixture of carbol-fuchsin and resorcin, similar to that

dipped in the dye and run around the outside of the block. The mid-point of each side is also marked, for ease in centering. This method of applying the dye is quick and easy. Because of the pressure applied, these fields do not usually look rectangular or straight when the pressure is removed, or when the patient is standing (Fig. 7).

The thickness of the patient is measured in such a way as to determine the distance through which the radiation will travel. The measure is taken, therefore, with pressure applied, and is usually the thickness from the mons veneris to the buttocks. The patient is frequently much thicker when lying with no pressure applied, or when standing.

Mapping the fields is merely a convenience in properly irradiating the pelvis. Each day the cone is placed so as to cover the marked fields. From this point onward the skill of the physician is needed. He must keep constantly in mind that he is not irradiating a certain rectangular area of skin, but rather structures within the body whose position relative to the surface he must constantly visualize. The skin can move to such an extent that, although the marked area is accurately covered by the cone, the interior area is not the one desired. Films made under the conditions of treatment will readily show this to be true (Figs. 8 and 9). This applies especially to the lateral fields, which may shift several centimeters in any direction. They are, therefore, best marked with the patient in the actual position of treatment under the cone. The direction of the beam relative to the patient is the important consideration (Figs. 5 and 10). An attempt is made to treat with a vertical central ray, the patient lying flat. We find, however, that when pressure is applied, the patient and the cone are likely to change their angle relative to each other.

It is hardly necessary to point out that no nurse or technician has the knowledge necessary to place patients for treatments. Each separate position for treatment must be carefully and accurately checked by a

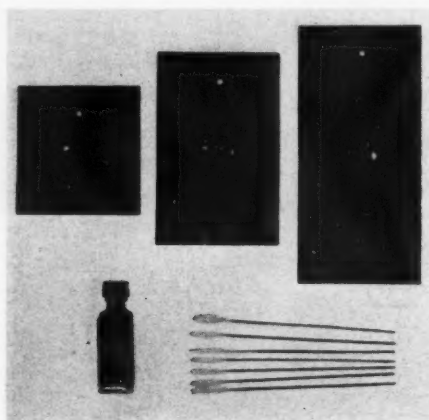


Fig. 7. Marking blocks, applicators, and dye.

sold under the trade name of Carbo-fung, is excellent. The complete formula is:

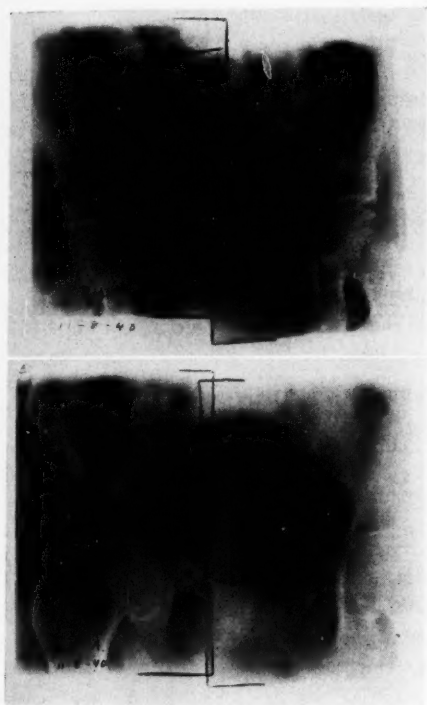
Resorcin.....	9.0
Fuchsin.....	1.6
Phenol.....	4.8
Acetone.....	6.8
Alcohol.....	13.0
Distilled water.....	120.0

It can be removed, if necessary, with acid alcohol consisting of 2 per cent hydrochloric acid in 80 per cent alcohol. A very small number of patients have reacted to this marking ink with a mild local dermatitis.

Blocks of hardwood, with handles, were made up to sizes of the more usual fields. Singly or in combination, they permit fields of various sizes to be marked. They are lacquered for easy cleansing. The desired size is placed on the field of skin chosen and pressure is applied to the same degree as that obtained with the treatment cone. An applicator wrapped with a small amount of absorbent cotton is

physician. The unfortunate practice followed by some roentgenologists of relegating this important part of their work to a technician is analogous to a surgeon's permitting his nurse assistant to remove an appendix. Such a practice is one of the reasons why other physicians regard x-ray therapy as a purely mechanical procedure to be directed by prescription.

direction of the rays would be much more difficult. This has been demonstrated on patients treated for lesions of the prostate and bladder, as well as those with carcinoma of the cervix or fundus of the uterus. Secondly, a large region has to be irradiated to include all the lymph nodes. Such a volume of tissue can be covered more accurately and uniformly with fields ap-



Figs. 8 and 9. Roentgenograms made after the patient had been set up for therapy. The proper "field area" was covered, but improper angulation of the cone, unperceived angulation of the patient before or after the cone was put in position, shifting of the skin, or carelessness on the part of the therapist has resulted in irradiating somewhat wrong regions. Try it on your own treatment set-up.

Some therapists have departed from the four-field or six-field technic, preferring to use a greater number of smaller fields. This method has not been employed even with our 1,000 kv. apparatus, for two reasons. First and foremost, it is not easy properly to aim even a vertical beam, 10 × 15 cm. in cross-section, and with smaller fields and more unusual angles correct

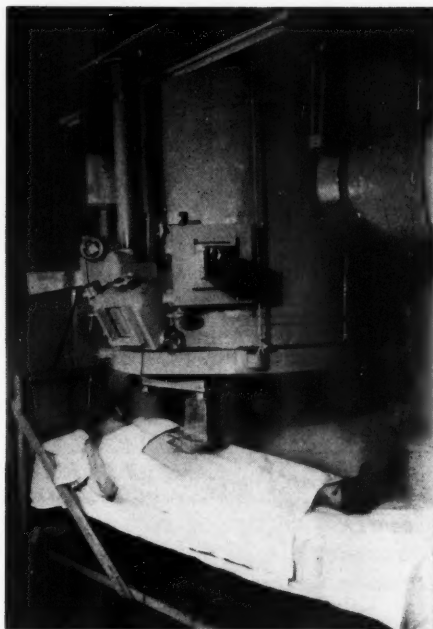


Fig. 10. Patient "set-up" for treatment with vertical rays on the Sloan high-frequency generator (H.V.L. 9.5 mm. Cu).

proximating the cross-sectional area of the region. Moreover, with either 200 or 1,000 kv. apparatus it is possible to deliver to the pelvic cavity, through the fields described above, all the radiation that the tissues will stand, without undue damage to the skin.

The fields having been selected and the angle of the beam determined, the question arises as to the amount of radiation to be given. When 200 kv. x-rays are used, our standard daily dose is 200 r in air (272 + r on the skin) to an anterior and a posterior port on the same side of the pelvis one day, and the ports on the

opposite side the next day. When lateral ports are used, we try to treat the right lateral port on the same day that the anterior and posterior areas on the right are irradiated. Most frequently, however, only two ports can be treated each day, because of the patient's reaction. In this event both lateral ports are treated every third day. On the first two days of treatment only 100 r per port are given. This is done because the tissues are more readily accustomed to irradiation, and patients overcome their fear of the apparatus more easily, if they do not get any untoward reaction from the first treatment.

causing bloody discharge from the bowel, although severe diarrhea is almost always produced.

With the 200 kv. constant potential apparatus, a filter of 0.5 mm. Cu + 1.0 mm. Al is used and the half value layer in copper of the rays is 1.05 mm. The rate of administration is 21.3 r per minute, and the distance 80 cm. When the 1,000 kv. Sloan high-frequency apparatus is used, the quality of the radiation changes to 9.5 mm. Cu half value layer, and the rate to 25 r per minute. The distance remains the same. From 300 to 325 r in air (354 r on the skin) are given, and treatment is carried to totals of between 3,250

IRRADIATION OF PELVIS

Patient 23 x 35 Cm.

200 KV, .5Mm. Cu + 2 Al, Dist. 70 Cm.

SKIN DOSE (AIR r + BACKSCATTER) = 100 %

Two 20 x 15cm. fields 1 A, 1 P.		Four 10 x 15cm. fields 2 A, 2 P.	
Cervix	60-70%	Cervix	60-70%
Parametria	40% +	Parametria	40% +
Bladder and Rectum	70-90%	Bladder and Rectum	60-70%
Four fields — { A. and P. 20 x 15 R. and L. lat. 10 x 15		Six fields — { Two 10 x 15 A. Two 10 x 15 P. Two 10 x 15 L.	
Cervix	80%	Cervix	70-80%
Parametria	80-95%	Parametria	80-90%
Bladder and Rectum	80-95%	Bladder and Rectum	60-80%

From Anneson and Quimby: *Radiology* 25:182, 1935

The treatments are continued daily except Sundays and holidays, rotating the ports in the manner mentioned, until each port has received 1,900 r. At this time the reactions of the patient as a whole, and of the skin and mucosa, are carefully reviewed. If we judge that the patient can tolerate more, treatment is continued until a dose of 2,300 or even 2,700 r has been directed to each port. Each patient should be taken to her point of tolerance regardless of the gross or microscopic pathological changes. The tolerance may be that of the skin, the intestinal mucosa, or the patient as a whole. An attempt is made to avoid carrying therapy to the stage of

and 3,750 r. The reasons for the different doses on the two machines and the effect on the depth doses were discussed in previous presentations (9, 11).

For the last two years we have been treating the right side of the pelvis of each patient with 200 kv. radiations (H.V.L. 1.05 Cu) and the left side with 1,000 kv. radiation (H.V.L. 9.5 Cu). This was done for the purpose of comparing the reactions in the skin produced by the two qualities of radiation and has been reported (9). Some of these patients have had Wertheim operations and some have had removal of the pelvic lymph nodes. The gynecologists have been unable to determine any dif-

ference in the reactions of the intra-pelvic tissues to the different qualities of radiation.

The question of the distribution of tissue doses throughout the pelvis has been most thoroughly covered by Quimby and Arneson (10). Their article should be referred to for a detailed discussion of this subject. It is illustrated by instructive isodose diagrams. The accompanying table is constructed from the data which they provided. This shows that the two-field technic, one anterior and one posterior field 20×15 cm. in size, produces the poorest distribution of tissue dosages. Comparatively small doses are delivered to the cervix (from 60 to 70 per cent) and parametrium (40 per cent +), while the bladder and rectum get comparatively large doses (from 70 to 90 per cent).

The technic which employs two fields anteriorly and two posteriorly, each 10×15 cm. in size, results in no greater dose to the cervix and parametrium, but does decrease the dose to the bladder and rectum (60 to 70 per cent). This technic delivers an inadequate dose to the parametrium and lymphatic bed.

The four-field technic, utilizing large anterior and posterior fields 20×15 cm. in size and smaller fields 10×15 cm. in size laterally, increases the cervical dose to 80 per cent and the dose to the parametrium to 80 to 95 per cent. At the same time, however, it increases the dose reaching the bladder and rectum to 80 to 95 per cent.

The six-field technic, two anterior, two posterior, and two lateral fields, each measuring 10×15 cm., delivers almost the same dose to the cervix and parametrium as that obtained by the four-field technic just described, but decreases the dose to the bladder and rectum. Thus the six-field technic is to be preferred in most instances.

On the other hand, the four-field technic, with a large field, 20×15 cm., anteriorly and posteriorly, and fields 10×15 cm. laterally, is better if for some reason radium is not to be employed, or if there is extensive mid-plane involvement which

cannot be controlled by radium alone. In such an instance the cervix and contiguous tissues should be treated as well as the parametrium and lymphatic bed. The consequences of excessive irradiation of the bladder and rectum must be disregarded because these structures or adjacent tissues are involved.

We prefer fields 20×20 cm. in size to those 20×15 cm. described by Arneson and Quimby because, in patients with advanced disease, the lumbar nodes are frequently involved. It should be noted that Quimby and Arneson made their calculations for a patient 23 cm. in thickness and 35 cm. in width. In smaller patients, the distribution of the radiation changes considerably. Our average patient is 18 cm. thick and 32 cm. wide. For a patient of this size, or smaller, the technic using four fields 10×15 cm. in size will deliver approximately the same dose to the lymphatic bed as that delivered by Quimby and Arneson's six-field technic with a patient 23×35 cm. in size. The distribution, however, is not so uniform. If a six-field technic is used on these patients it will be necessary to decrease proportionately the dose to each field, because as large a dose has been delivered to the pelvic structures as we feel is justified. This, however, will be advantageous, because the same doses can be delivered to the tissues with less reaction on the part of the skin.

Can anything be accomplished by external irradiation of the lymph nodes? Taussig showed that when the nodes are removed surgically after irradiation, they show very little change, and that a higher percentage of patients had cancerous nodes who had been treated by irradiation than those who had not. Another way to study this problem is by length of survival. It may be of no importance to the patient to have quiescent cancer cells in her lymph nodes, if her health continues to be good in spite of their presence.

Morton (1) made a study of the five-year survivals among 79 patients who had had radium treatments only, prior to 1931, and among 58 patients treated with radium

and x-ray between 1931 and 1934. The character of the radium therapy to the local growth was much the same throughout both periods. Of those treated with radium only, 15.2 per cent were alive after five years, but of those treated with both, 39.7 per cent were living after five years. Approximately 80 per cent of the patients were considered inoperable (III and IV Schmitz) in the two groups, so that a large number undoubtedly had involvement of the lymph nodes, about 50 per cent according to most authorities. Something must have happened to stop the growth of the cancer in the nodes, even though the neoplastic cells may not have been destroyed.

This higher rate of survival cannot be ascribed to our present method of x-ray therapy. Throughout most of the period considered, 200 kv. therapy (H.V.L. 1.05 Cu) was being used with one anterior and one posterior field, each 20×20 cm. in size, and lateral fields of 10×20 cm. All four fields were treated on the same day and treatments were given three times a week. Two hundred roentgens in air per field were given at each sitting, and the totals seldom exceeded 2,000 r in air per field. In the summer of 1934, when use of the 1,000 kv. radiation was begun, anterior and posterior fields 20×20 cm. in size were still used, but the lateral fields were omitted because we thought we were getting as much dose as the tissues could stand from the two fields. At first 316 r per field per treatment were used, but the patients became too upset and the amount was decreased to 240 r in air. Of the first 35 patients treated, only 31.4 per cent survived for five years, in contrast to 42.9 per cent of the last 35 treated on the 200 kv. apparatus. In both groups the distribution of patients with the various stages of disease was about the same. Did the decrease in percentage of survival arise from the fact that lateral fields were omitted and therefore the nodes were less affected, or from the use of 1,000 kv. radiations, or from imponderable changes in the

stage of the disease that could not be determined by physical examination?

SUMMARY

1. In the plan of treatment now in use the lesion in the cervix is irradiated by radium.

2. The roentgen rays are directed primarily to the regions of direct extension and to the lymph nodes.

3. From 30 to 50 per cent of patients with "operable" lesions have involvement of the lymph nodes.

4. From 10 to 20 per cent of patients with small local lesions, without parametrial involvement, have metastases in the lymph nodes. Therefore, not only those patients with large lesions but also those with small ones should have irradiation with x-rays, unless a radical Wertheim operation is to be performed.

5. Ninety per cent of lymphatic involvement occurs in the primary nodes, which consequently must be included in the regions irradiated. These primary nodes are: (a) the hypogastric—beside the hypogastric artery just below the bifurcation of the common iliac artery; (b) the obturator, on the obturator nerve near the femoral ring; (c) the iliac nodes, along the external iliac artery at and below the bifurcation of the common iliac artery; (d) the sacral nodes, on the anterior surface of the sacrum; (e) the parametrial nodes, including the ureteral node.

6. Direct extension of the cancer into the parametrium and vagina may occur, and fields must include these structures.

7. Accurate aiming of the beam is as important as selecting the fields on the skin and the amount of radiation to be given. Technicians should not be given this responsibility.

8. The amount of irradiation given should be all that the normal tissues can tolerate. Six fields produce the best internal distribution of the radiation.

9. Five-year survivals of patients treated by a combination of radium and x-rays from a 200 kv. unit (H.V.L. 1.05

Cu) indicate that the growth of the cancer is retarded or destroyed by x-rays.

We wish to express our thanks to Dr. Ole A. Nelson of Seattle, who loaned us several films of patients, made after he had injected the abdominal aorta with radiopaque material.

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IRRADIATION IN CANCER OF THE CERVIX UTERI¹

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THE choice of our subject, in response to an invitation to participate in a symposium "on the ideal *versus* the actual practical methods of irradiation in pelvic cancer," has been carcinoma of the cervix uteri both because it is the most prevalent form of pelvic cancer and because, in spite of wide experience in its treatment, there remain unsolved problems in its management.

The ideal treatment of carcinoma of the cervix at this stage of our knowledge might be defined as that one which permanently rids the patient of her disease with the least possible damage to other tissues than the cancer. The problem, however, is greatly complicated by the extreme variations of the disease—variations manifest in the site of origin in or on the cervix, the degree and routes of anatomic spread, and the biologic type of growth as the tumor extends or lodges in tissues which impose varying environments upon it. We come, therefore, to the obvious conclusion that there is no ideal treatment. The question resolves itself into: "What are you actually doing with cancers of the cervix?"

We are first of all attempting to make as accurate a diagnosis as possible in the individual patient. Before embarking upon any therapy, we try to evaluate the anatomic limits of growth and the effect the disease has had on the patient. This includes the effect of other diseases or states upon the growth of the cancer. Beyond the information which we gain from the history and general physical examination, the investigation leads us to cystoscopy and intravenous urography in a large proportion of the patients. Since death will most commonly be due to ureteral occlu-

sion, it is well to know in advance the status of the urinary tract. In the past two and a half years we have seen 10 cases of ureteral obstruction of varying degree in a group of 58 patients. Among 19 stage IV cases in which intravenous urography was done, one half showed some degree of ureteral obstruction. In 3 of these the obstruction was bilateral. Our own experience with cancer of the cervix (and many other forms as well) has been that we tend to underestimate the extent of the growth.

In a previous report (1), with Dr. John Wirth, we have analyzed the failures in treatment of cancer of the cervix in a group of 107 cases treated from 1935 to 1938. Since that report we have seen 58 additional cancers of the cervix. Of the total 165 cases, 131, or 80 per cent, were in stages III and IV; 69, or 40 per cent, were in stage IV. In the past two years we have refused treatment to 12 of 28 stage IV patients for reasons either of age, previous treatment, general condition, or extent of the disease. We do not accept either stage III or IV cases for treatment with palliation as the sole aim. Our results, or rather our failures, in advanced stages indicate that palliation either is not obtained or is not of sufficient degree or duration to justify the extensive treatment to which the patient is subjected. It is true that in many of the stage IV patients we are forced to discontinue the treatment short of completion. Patients with ureteral obstruction have been treated in order to obtain, if possible, a return of ureteral function. In one such case in 6 treated in the past two years (judged stage III), with an almost complete unilateral obstruction, full return of normal ureteral function has been maintained for one and one-half years.

Our treatment follows no outline or rigid

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technic. The anatomy, the disease, and the constitutional reaction of the patient to the disease and the treatment, are the guiding factors at all times. We shall stress this individualization of treatment throughout the following discussion; yet the treatment of each patient is based on general principles common to all. Radiation therapy would be immeasurably improved if such terms as "pelvic cycle," "roentgen series," or the naming of a particular "technic" could be omitted. Such terms point, psychologically, to standardization of treatment in a disease which should be considered from the point of view of individualization for the particular patient at hand.

In all except stage I cases, we aim to supplement radium therapy by external roentgen irradiation. This results in the treatment of stage II and stage III patients by the combined method. In stage IV the anatomic conditions make radium application impossible. Roentgen irradiation, for the most part, is given with an apparatus operating at 800 kv., 10 ma., 4 mm. lead filtration, 100 cm. distance; the intensity as measured on the skin² with a Victoreen chamber is 23.5 r per minute for a field of 10×14 cm.

Intra-uterine application of radium is carried out when the patient has no fever. The length of the uterine canal is determined, if possible, before cervical dilatation and intra-uterine application. It is important that the radium sources within the uterus correspond to the total length of the cervical and uterine canal. Cervical dilatation under anesthesia is of the least possible degree necessary to permit the introduction of a flexible rubber-silk sleeve containing the radium sources (Fig. 1). We prefer to limit the intra-uterine charge to a maximum of 40 mg. (1 mm. platinum filtration), using two 20 mg. sources for a canal of 5 or 6 cm. Longer canals require additional sources in the ratio of 20-10-10 mg. (from fundus to external os); for still greater lengths, units of 10 mg. are used.

² All roentgen doses include skin back-scattering unless otherwise stated.

In this latter case, when the canal may measure 9-12 cm., we have increased the intra-uterine dose to 5,000-8,000 mg.-hr. instead of the more usual 4,000 mg.-hr. The time of application has been increased or two applications are made with an interval of a week. Our more constant maximum intra-uterine dose has been around 4,000 mg.-hr., given in a single application requiring four or five days.

The vaginal application has been made at a separate time, usually following intra-uterine treatment. The interval between the two applications has ordinarily been not more than twenty-four hours. The

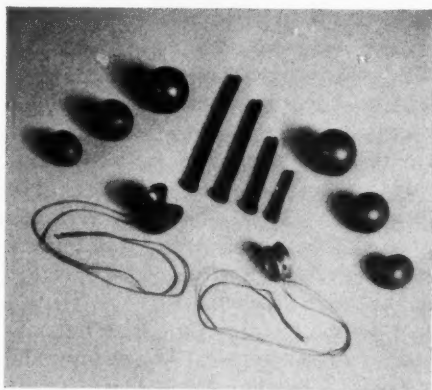


Fig. 1. Silk-rubber semi-rigid intra-uterine radium applicators of varying lengths, and ovoids of different sizes for vaginal application of radium, with spacers.

vaginal applicators are of the type developed at the Holt Radium Institute, Manchester, England (5). These are rubber ovoids used in pairs with a special spacer, the combination amounting virtually to a separable colpostat (Fig. 1). The ovoids are molded so that the outer surface conforms with an isodose curve of the contained radium tube or tubes. Inadvertent rotation of the applicator *in situ* is then of secondary importance. The ovoids are available in three sizes (2, 2.5, and 3 cm. in diameter) and relative loading of 3, 4, and 5 units (15, 20, or 25 mg.) of radium is designed to produce equivalent dosage. Spacers 1 mm. or 1 cm. in thickness may be used. Six combinations of size are there-

fore available; the largest combination that can be introduced is the optimum selection. The arrangement of 2 medium ovoids with the 1 cm. spacer is the most frequent, and all specific radium doses mentioned in this paper are based on that combination. The applicators are usually inserted under anesthesia, because of the greater facility of packing both behind and in front of the applicators, which cannot be as adequately done when the vagina is not relaxed. The vaginal dose thus applied is ordinarily around 4,000 mg.-hr. given in four or five days, and in one application.

The "optimum" dose of radium which can be given to any particular cancer of the uterine cervix is actually undetermined. We know only in general what the cervical tissues and the adjacent rectum and bladder will tolerate under hypothetical average circumstances. When the anatomic conditions permit, we attempt to give a total radium dose of about 8,000 mg.-hr. In so doing we are following the experience of Regaud and Lacasagne. Rarely have we exceeded this dose. When we have fallen short, the reason is in almost every instance an anatomic one. In cancer of the cervical stump or recurrent cancer following surgery intra-uterine radium therapy has in general been impossible. A short uterine canal (*i.e.*, less than 5 cm.) presents a somewhat similar problem; here we have reduced the intra-uterine dose to about one-half of the usual 4,000 mg.-hr. and given an additional 4,000 mg.-hr. paracervically. The intra-vaginal dose has also been modified as required by anatomic irregularities.

In combining radium and roentgen irradiation we feel that the preferable sequence is radium first, followed by x-ray therapy. We are of the opinion that of the two sources of radiation (radium and x-ray) the radium is the more essential in stages other than IV. We do not wish, therefore, to jeopardize the possibility of giving adequate radium therapy by any complication or concomitant of the roentgen irradiation, such as a rectal or vaginal reaction, or, as has occurred, a marked in-

crease in the local and parametrial disease during initial x-ray treatment.

We cannot always begin treatment by either intra-uterine or vaginal radium application. Local and parametrial infection are best combatted by initial roentgen irradiation. Moderate or profuse hemorrhage cannot be blocked in the uterus or vagina by radium applicators and packing; the risk of infection is too great. A fungating growth on the cervix may close the external os or be of a size that radium applicators cannot be placed to best advantage. In the presence of a sclerosing and necrosing growth the canal may not be patent, and may become less so if one begins with vaginal radium rather than x-ray in the hope that the canal can subsequently be found and an intra-uterine applicator used. In the great majority of stage IV growths we have no hope of being able eventually to use radium therapy in any form. In all of the instances of anatomic obstacles to proper radium application just mentioned—infection, hemorrhage, or excessive extent of the disease—the initial treatment is by roentgen irradiation. In reviewing our records we find that when, for one of the reasons stated above, we have begun the treatment by x-ray therapy, we have been more prone to complete this phase of the treatment than to interrupt it to give radium. These cases were, on the whole, more advanced than those in which we began with roentgen irradiation because of bleeding, and then, when this was controlled, interrupted the treatment to insert radium, later completing the x-ray therapy. This latter group, in whom radium therapy was given during an interruption of the x-ray treatment, sustained in general a more noticeable rectal reaction.

We do not feel that a rectal reaction can be entirely avoided in treatment of cancer of the cervix. The cervix and rectum are too close to each other to permit adequate irradiation of the cervix without in some degree affecting the rectum. If one attempts to avoid all rectal irritation, then one is not adequately treating the

paracervical region. This reaction can, however, be minimized; late severe reactions, either ulcerative or stenotic, result from either too intense or too massive doses, or incorrect application of radium. We are, after all, dealing with a lethal disease, and a transient diarrhea is not to be compared with the permanent alterations in bowel function which our surgical colleagues produce to eradicate other forms of cancer. A moderate diarrhea during roentgen irradiation necessitates a diminution in the dose until the reaction has subsided. When it appears near the completion of treatment and is associated with tenesmus, it serves as a sign necessitating caution in the total dose. Perhaps too, and particularly with supervoltage therapy, we may confuse a higher intestinal irritation with rectal irritation. We find in review that we do not do enough proctoscopic examinations to know the difference between these two reactions. Rectal tenesmus is a more certain sign of proctitis than is diarrhea. An upper intestinal reaction will invariably produce a diarrhea, and calls not only for alteration in the intensity of treatment, but for dietary regulation as well.

To us it is surprising that the rectal reactions following radium therapy are not more severe and more frequent. Actually, if one computes in terms of roentgens the dose received by the rectal mucosa when 8,000 mg.-hr. radium therapy are given, the figure is around 3,000-4,000 r.

As previously stated, radium therapy given during the interruption of x-ray therapy has increased the rectal reaction. In none of these cases in the past two years has a severe reaction persisted. Radium therapy in doses of 6,000-8,000 mg.-hr., when given too rapidly (in less than eight to ten days), and particularly when given with radon, in which the initial strength of the source is high, has almost invariably been followed by a more severe proctitis than when lesser intensities emanating from radium element are used.

Roentgen therapy alone in advanced cancer of the cervix has to our knowledge

been effective only in those growths which tend to infiltrate downward into the vagina rather than into the parametria and pelvis. They are more commonly of an undifferentiated histologic type, more radiosensitive than the cancers which infiltrate the parametrium or adjacent organs. Baclesse (3) has reported a group of 63 cases of advanced cancer of the cervix with 9 or 14 per cent cured by roentgen therapy alone. Among all the patients with stage IV disease (48) treated at the Swedish Hospital from 1935 to the present, by x-ray alone or in combination with radium, none to date is unquestionably free of disease. These results do not, however, discourage us from treating about half of the stage IV patients who come for examination.

The choice of fields in x-ray therapy for cancer of the cervix is highly important, whether one uses 200 kv. or supervoltage. The fields commonly used, and the ones which we employ to a large extent with 800 kv., are 2 anterior suprapubic and 2 posterior lumbo-sacral. When using these fields in combination with radium therapy, we do not tilt the pelvis to direct the beam medially. When the location of palpable extension directs us to increase the dose through the parametrium on one side beyond that given to the opposite side, we sometimes employ an oblique ischio-sciatic field as well. Six fields (2 suprapubic, 2 lumbo-sacral, 2 ischio-sciatic) are used at times to diminish the surface dose to any one field when the total dose is carried beyond 12,000 r. The ischio-sciatic field has actually been of less importance to us in using supervoltage than were we using 200 kv. more regularly. It was originally used by Coutard, and has been well described by Baclesse (3). The beam enters the pelvis through the sacro-sciatic notch (a soft tissue rather than a bony entrance), following a path inward and forward to reach the obturator foramen of the opposite side (Fig. 2). This field needs to be placed under vaginal examination, which is true also for the other pelvic fields if we are to increase the effectiveness of the irradiation.

Patients are treated once, and only occasionally twice, daily. The daily dose is given through a single field, the sequence of fields being rotated unless there is some reason to concentrate the treatment to one area more than to another. Localized or radiating pain from infiltration, hemorrhage, or a contrasting extension to one side as compared with the other, are signs which have altered our sequence of fields in an attempt to increase the speed of irradiation to a particular focus. This has

out of the inferior outer corner of the field. This is made possible by a light-centering device on the open tube head, permitting a visualization of the field and the possibility of interrupting the beam over any area desired by the interposition of lead. This procedure avoids the severe reactions that may otherwise result in the inguinal folds. Unless the growth is one which extends down the vaginal wall, we aim to avoid irradiation of the vulva and its accompanying radio-epithelitis. It would

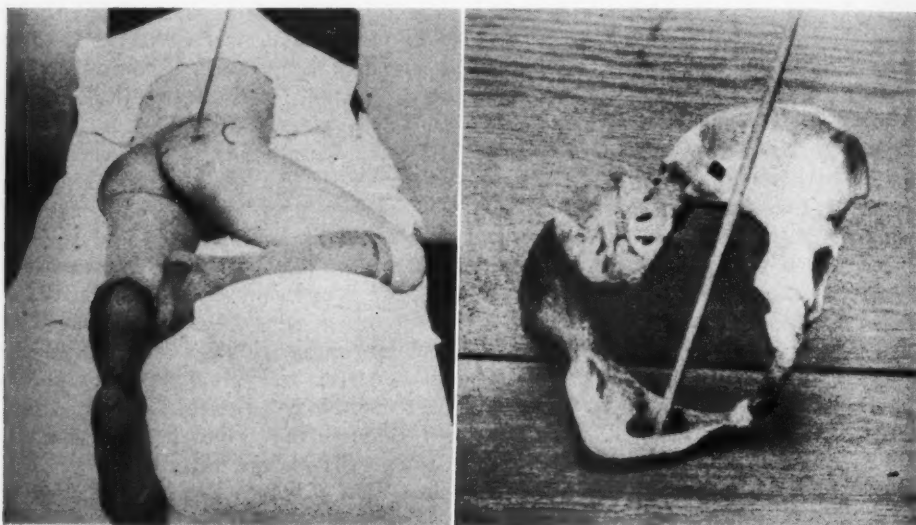


Fig. 2. Position of patient and direction of beam with the oblique ischio-sciatic field (after Baclesse).

also led us to increase the daily dose from 400–500 r up to 800–1000 r.

The size of our fields has depended upon the size of the patient³ and on the palpable extent of the disease. We have not exceeded a field size of 10 × 14 cm. in our larger patients (antero-posterior diameters of 23–30 cm.). In smaller patients (18–22 cm.) the fields have more frequently been 10 × 10 cm. The oblique ischio-sciatic fields, used in addition to the lumbosacral fields, are circular and of 10–12 cm. in diameter. We protect the inguinal folds and upper femoral areas, blocking them

seem almost unnecessary to add that no patient is installed on the apparatus by other than one of two physicians familiar with the case.

When we undertook the use of 800 kv. roentgen therapy about two and a half years ago, our experience had been previously with 200 kv. and to a more limited extent with 400 kv. We were therefore guided by the work of Dr. Wirth, who preceded us at the Swedish Hospital, and who had been using supervoltage since 1935. As previously reported (1), cancer of the cervix had been treated (1935–1938) in general by a combination of, on the average, 4,000 mc.-hr. of radon therapy and

³ External pelvic measurements are from the symphysis pubis to the first sacral vertebra.

3,500 r (measured in air) to each of 4 pelvic portals, generally given in four or five weeks. In reviewing these cases with Dr. Wirth, we came to the conclusion that certain complications and failures (rectal and intestinal damage, late fibrosis, uncontrolled disease) might be more often avoided by an increase in the radium dose (using radium element in place of radon) over a longer period of time, and possibly by a decrease in the total roentgen dose, at least in those patients with average or smaller pelvic diameters (18–22 cm.). This latter decision was also influenced considerably by caution resulting from our inexperience with supervoltage therapy.

Whereas the total roentgen dose from 1935 to 1938 had averaged in the neighborhood of 3,500 r (measured in air) to each of 4 pelvic portals in four weeks, we have in the past two years diminished the total roentgen dose in the smaller and medium pelvic range (18–22 cm.) to around 10,000–12,000 r (measured on the skin) given in five to seven weeks. We have, for reasons of extension of disease, carried the dose to 14,000 r in this pelvic range, in conjunction with 8,000 mg.-hr. of radium therapy. In patients with greater pelvic measurements (23–26 cm.) we have still not exceeded 14,000 r (measured on the skin). The total dose given to any one field has usually not exceeded 3500 r (10×14 cm.). When we have used more than 4 fields this dose has, of course, been less. Skin reactions have only rarely progressed beyond the stage of bronzing or dry scale.

The dose on the skin is, however, of relatively less importance than the dose received in the tumor, or in those regions assumed to be invaded by metastases. We felt that the closest measurement of the pelvic dose contributed by x-irradiation could be obtained only by constructing a model pelvis and measuring the dose at known points. The model was constructed by the laborious procedure of obtaining the contours from the human figure at each centimeter level from the

upper third of the thighs to well above the umbilicus. These separate contours (obtained with the subject standing within a frame which was elevated centimeter by centimeter) were then cut from presdwood after a paper pattern of each level. When smoothed down the result is a striking reproduction of the external anatomy of the subject (Fig. 3). We purposely selected a subject with a pelvic diameter above the average (26 cm.) because we were interested to determine the dose

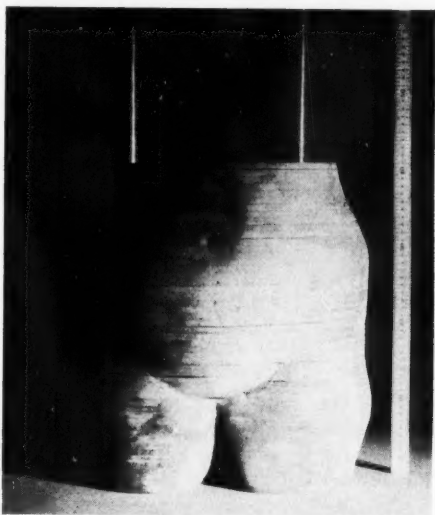


Fig. 3. Presdwood model of pelvis in multiple sections, as described in text.

under adverse circumstances. A second model, made from the first, was composed of 1 cm. presdwood sections in the coronal plane. Successive layers were removed to measure the pelvic doses with varying pelvic diameters. The cervix was located in the original model by as careful measurements as possible from the subject, and from known anatomy. The segmented construction permitted the placement of the Victoreen chamber within the model at selected points.

The principal points selected for measurement were (Fig. 4) the external os (*B*), and points 4 cm. above and 5 cm. lateral to the external os (*J*). These latter points were chosen as representing the more com-

mon locations of lymph node metastases in the periphery of the pelvis. Other points were explored for the construction of isodose curves in the plane defined by the triangle *JB**J*.

In the irradiation of the model, 4 fields of 10×14 cm. were used, corresponding as nearly as possible to those used in actual practice when two opposing anterior and

above, which means that blocking off of the inguinal regions does not prejudice the dose in the region to be irradiated. In a medium pelvis (22–24 cm.) the doses in the two regions, central and peripheral, are approximately 2,300 r and 3,000 r. In smaller pelvis (20 cm.) these doses are 2,500 r and 3,500 r.

The contribution by scattered radiation

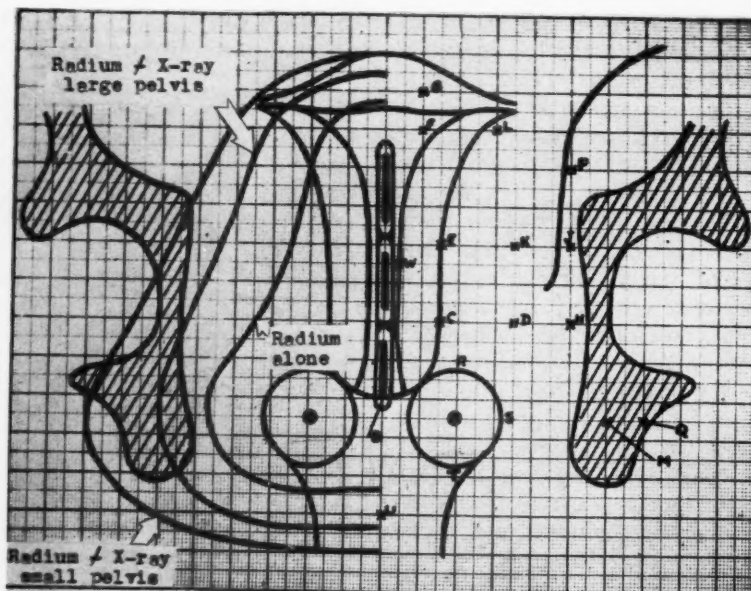


Fig. 4. Isodose curves describing the approximate limits of a pelvic dose of 4,500 r given by 8,000 mg.-hr. of radium and its addition to the x-ray dose of 3,500 r to each of four pelvic portals in pelvis of varying diameters.

posterior fields are used. The inguinal and upper femoral regions were omitted from the anterior fields, as in actual practice.

The depth dose contributed to each point was based on a skin dose of 3,500 r given to each of the fields. In a model of this size (26 cm.) the roentgen contribution to a central band through the cervix and uterine canal is approximately 2,000 r. This band is 2 cm. wide at the cervix, and 5 cm. wide at a level 4 cm. above the cervix. The dose at point *J*, that reaching the soft-tissue inner pelvic wall at about the mid-point of attachment of the broad ligaments, is approximately 2,600 r. The dose lateral to the cervix is higher than the dose 4 cm.

to a skin field from the 3 remaining fields to the incident dose on the field directly irradiated is relatively small—of the order of 25 per cent for a pelvis of 20 cm. and 15 per cent for a pelvis of 26 cm.

Before discussing the pelvic doses contributed by roentgen irradiation, let us consider the contribution at the various points from radium. We realize full well that we are exceeding orthodox custom in directly adding to a measured dose of roentgen radiation a dose of gamma radiation stated in roentgens. This has somewhat more justification with supervoltage than it might have with lower voltages. We realize, also, that we are not taking into

account variations in biologic effect due either to the rate or speed of irradiation or those perhaps inherent in the two qualities. As a working basis, however, to serve as a guide to the quantitative result of our total irradiation, we feel that this is thus far the only procedure at hand (4).

The radium contributions at the various points in Figure 4 are derived from the calculations of Sandler (2) at the Holt Radium Institute. We have extended these calculations to all relevant points in the pelvis, employing the radium arrangement which is most frequently used. From Figure 4 it will be seen that an isodose curve has been constructed defining what we may term as the maximum useful limit in space of the dose contributed by 8,000 mg.-hr. of radium. This curve represents along its entire length a dose of approximately 4,500 r. As compared with the radium contribution to the cervix itself, the dose at this distance is certainly on the low side, but it gives us a guide to the range of radium effectiveness. The middle isodose curve is that representing the combined effect, in roentgens, of the same radium dose plus the x-ray dose (3,500 r to each of 4 pelvic fields given to the model of 26 cm. diameter pelvis as described), the dose along this curve also being 4,500 r. The outer isodose curve represents the limits in space of the same combined radium and x-ray dose to a smaller pelvis (20 cm.), 4,500 r reaching the periphery as defined by the curve.

From the standpoint of quantitative determinations only, what do we gain from all these measurements? We are first of all impressed by the relatively low x-ray contribution of 2,600 r to the combined dose at the periphery of the broad ligaments in a large pelvis. This is not contradictory, however, to known clinical facts, for x-ray therapy alone rarely cures a cancer of the cervix which has spread up into the broad ligaments and laterally to the pelvic walls. We see, also, that the effective range of radium, as we are using it, is sufficient for stage I, and that for stage II, in which we dare not assume that the

disease has not spread beyond the cervix, the x-ray contribution to the cervix itself (when the beams are not aimed at the cervix) is minimal and not likely to increase the dose beyond the tolerance level. The most important interpretation, however, which we make from these measurements is pertinent to stage III. A high percentage of these patients still die from uncontrolled parametrial disease when treated by combined roentgen and gamma ray therapy. We are brought to the conclusion that, from the dosage point of view only, either additional radium therapy or x-ray therapy, or both, may be needed to control outlying metastases. In a patient with a small pelvis it would seem that we could more safely gain this increment by increasing the radium dose and prolonging its time of administration. We feel that wherever radium can be used its effects are more localized to those regions which one desires to irradiate, and are less on normal structures. In a larger patient, as represented by our model, the x-ray doses could be increased with more safety than is possible in a smaller patient, and the radium dose could as well be higher in stage III.

It would seem to us that the procedure of routinely beginning treatment by completion of the roentgen irradiation in stages other than IV, when the anatomic possibility for satisfactory radium application is present (and in the absence of fever or hemorrhage), is not well founded. If one agrees that the radium (if given in doses of 8,000 mg.-hr. or more) is the more important contributing radio-active source, then the conditions for safely carrying the dose to these limits should not be jeopardized by the complications which may ensue from external roentgen therapy carried to the limits of tolerance of the normal tissues. Furthermore, except in highly undifferentiated and relatively radiosensitive growths (which are infrequent in stage III cancer of the cervix), it is not sufficient merely to reduce the peripheral spread in the parametrium with the hope that the radium will then have a narrower range in

which it must do its work. The roentgen contribution to the periphery has to sterilize the outermost cells, and a dose which shrinks the periphery may not be one which prevents its extension at a later time. The problem is not one of bringing the tumor to the radium, but rather one of bringing the radium to the tumor in a quantity which is lethal. This imposes the necessity of utilizing the conditions for radium therapy when they are optimum, and when the possibility for increasing the radium dose beyond a previously planned limit is still possible, without having to consider the complications which may ensue in a patient who has undergone an intense course of roentgen irradiation.

As to stage IV, in which we are unable to use radium, we are not as yet laboring under the optimism that we shall increase the curability of these advanced lesions by the increase of the total dose alone, using supervoltage therapy. Irradiation through 4 oblique fields of 10×14 cm., cross-firing through the pelvis, directed to the cervix in our presdwood model (26 cm. anteroposterior diameter), contributed a more or less uniform dose of approximately 3,200 r throughout the pelvis when each skin dose was 3,500 r. In order to increase the pelvic dose materially (5,000 r) in a patient of this size, it would be necessary to increase the incident dose to each field by almost 50 per cent. In order to study radiation effects with the variation of factors other than the dose, we continue, therefore, to accept certain of these advanced cases for treatment.

We come in the final analysis to the conclusion that, although we have devoted a considerable discussion to dose, there are other factors of equal or greater importance which should concern us. The

biologic effects of radiation on malignant and normal tissues are, after all, of the first importance. In cancer of the cervix these effects can, in the last analysis, be judged only by the condition of the patient years after treatment. We are not so much concerned with the skin, and the fruit fly cannot be put in the parametrium. If he were, the irradiation effects on him might be considerably altered over that seen in the test tube or in phantoms. The environment or tumor bed in which a cancer grows, whether limited to the cervix or spreading to the vaginal wall, parametrial lymphatics, or into the bladder, determines in a large measure the effects of irradiation. We end by quoting Lacasagne:

"For a certain kind of cell, no lethal dose exists; . . . lesions in similar tissues, exposed to the same conditions of homogeneous irradiation, do not always show similar results. Only this is definite, that there exists no certainty either as to the probability of survival of tissues or a certitude of their destruction by any determined irradiation."

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TECHNIC OF IRRADIATION OF CANCER OF THE UTERINE CERVIX, COMBINING RADIUM AND SUPERVOLTAGE ROENTGEN RAYS¹

By ERIC LILJENCRA NTZ, M.D., and R. R. NEWELL, M.D.

From Stanford University School of Medicine, San Francisco

ABOUT 1923 we began to imitate the method of radium treatment of cancer of the uterine cervix used at the Radiumhemmet in Stockholm, by Forssell and Heyman. From that time until 1935 we depended almost entirely on radium, using x-rays only occasionally to attempt palliation of wide pelvic recurrences. Experience with much harder roentgen radiation (eventually h.v.l. = 2.7 mm. Sn) encouraged us in its use, and for the past three or four years we have inclined to the following plan (grouping according to League of Nations classification):

(a) Carcinoma of the cervix, Group I: Radium only.

(b) More advanced carcinoma, Groups II and III: External irradiation with x-rays followed by a single placement of radium.

(c) Very extensive carcinoma, Group IV: Sometimes x-rays or radium, in moderate dosage, for palliation.

Our experience is too brief to give dependable statistics. To limit discussion to the second category, namely Groups II and III, treated by x-rays of h.v.l. 2.7 mm. Sn, followed immediately by cervical and vaginal radium application, we have 5 patients well three years. Forty are living less than three years after treatment, 30 of them more than one year, but 13 have cancer still visible. Fourteen patients so treated have died, 2 having lived two years, 6 one year, and 5 less than a year, all continuing to show cancer until death. All but 2 of these were in Group III.

In a word, we see 32 immediate good results among 59 patients in Groups II

and III treated in one particular way. We are encouraged to continue its trial.

THEORETICAL APPROACH

At 200 kv., with filtration to give a half value layer of about 1 mm. Cu, scattering is such a large factor in building up the dose in the middle of the pelvis that little is gained by using multiple small ports compared with two large ones, an anterior and a posterior. The cervix lies so far from the lateral ports that one gets a discouragingly small reward for adding them to the anterior and posterior ports.

At supervoltages, even with a half value layer up to 10 mm. Cu, Stone has shown no improvement for anterior and posterior port cross-fire unless the pelvis is more than 20 cm. thick, since the increased 10 cm. depth dose is offset by the high exit dose.

Better advantage could be obtained from supervoltage if multiple narrow beams were used and so directed as to emerge through skin outside of the entrance ports. Van Roojen, in South Africa, as long ago as 1928 developed a cone to direct four beams into the pelvis as if from the faces of a tetrahedron. This plan is theoretically perfect and it was our original intention to follow it. Technical difficulties, however, induced us to compromise on three ports, at 120 degrees, one suprapubic and two postero-lateral (gluteal). Figure 1 shows the entrances and exits, and reveals that there is overlapping with a field as large as our routine, namely a 15 or 16 cm. circle. Doubting our ability to maintain 100 per cent precision in daily application, and wishing not to miss any portion of the true pelvis, we have used a smaller beam only in the smallest pelvis. Figure 2 shows the arrangement of the patient for a postero-lateral field.

Looking back on a long experience of

¹ Presented before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2-6, 1940.

severe vulvar erythema from the scattering from large ports front and back, we avoided the addition of the perineal field. We are now struck by the mildness of perineal reaction in most cases, due, we suppose, to the decreased lateral scattering from the harder rays.

Since external irradiation can never bring up the tissue dose in the center of the pelvis to a third the level achieved in the cervix with radium, it becomes necessary to add radium to the x-ray course. We could place the radium before or after x-ray irradiation. We argued that the

them was the hope that regression after x-ray therapy might be good enough to bring the outlying portions of the tumor within the reach of the radium. The decision, then, was quite definitely to employ x-ray first and radium at the end of the x-ray course.

Clinical observation develops two more factors: (a) Local infection is usually lessened by the time radium is applied, but (b) vaginal reaction may in cases impede radium placement.

DOSAGE

We treat these patients six days a week, with rotation of the three ports. Postero-lateral (gluteal) areas get ordinarily 400 r each time, and the suprapubic area 300 r. Back-scattering adds 20 per cent to these figures. In a month the approximate limits of skin tolerance will have been reached, 3,600 r of tissue dose in front, and 4,800 r gluteal. Roentgen sickness—even with the barbiturates, thiamin, and liver extract—diarrhea, or unusual sensitivity of the skin may any of them force a reduction of the daily dose and of the total given, but most patients carry through with surprisingly little sickness. Occasional patients have borne 6,000 r posteriorly. A good many have developed blisters. A few have ultimately shown some subcutaneous induration, notably one for whom we used 19 cm. areas.

We feel sure that we see many more patients with visible roentgen reaction in the vagina and with a visible influence on the tumor than we did when we were cross-firing with large fields front and back.

The radium is applied once, within a few days of completing the x-ray course. Filtration is 2 mm. platinum. Two 25-mg. tubes in a tandem arrangement are put in the cervical canal (if possible) and a 25-mg. tube, enclosed in a bulky bakelite "bomb" 2 cm. in diameter, is packed into each lateral fornix. To aid in holding these as far out and up as may be, the "bomb" is recessed for a 3-mm. steel rod, which makes a convenient handle which can be removed at completion of packing.

IRRADIATION OF PELVIS
THREE BEAMS 15 CM ROUND FIELDS

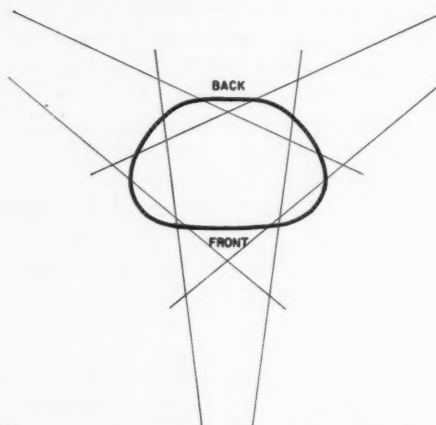


Fig. 1. Irradiation of pelvis from three directions.

best we could hope for from the x-ray would be reduction of the size of the tumor; the best we could hope for from the radium would be an effective cancer dose (say 8 or 10 erythema doses) out 3 cm. from the axis of the cervix. The external irradiation would add to this effect rather less than would be expected from a second radium placement a week later (as had previously been our custom). But 5 cm. out from the center, the radium would be only a quarter or a third as effective as x-rays.

We could expect the radium to be effective close in, and the x-ray to reach far out, but only to presumably ineffective intensity. The only basis for combining

The time is usually thirty hours, giving a total of 3,000 mg.-hr.

DISCUSSION

We are aware of Stone's demonstration of the biologic identity of effect of 200 kv. and 1,000 kv. x-rays on the pelvis, when applied similarly. There may be a physical advantage, however, in using super-hard x-rays by a narrow beam cross-fire technic not attainable with softer qualities.

It may be possible to get much more tissue dose into the cervix with radium than by x-ray cross-fire. But the wider distribution of x-rays in the pelvis may still make their use advantageous.

CONCLUSION

A practical technic is described for using radium and supervoltage x-rays together in the treatment of cancer of the uterine cervix. We hope that this takes better advantage of the strong points of the two agents than did our previous technic.

DISCUSSION OF SYMPOSIUM ON CANCER OF THE CERVIX UTERI

AXEL N. ARNESON, M. D. (St. Louis, Mo.): This symposium has been unusually interesting and valuable. It has been unique. So much material has been presented there seems no reason for injecting into the discussion anything on personal methods or technic, except to say that in our institution both daily and total doses, as well as periods of treatment, are somewhat less than those described by some of the essayists.

It is significant that none of the speakers advocated a single routine of treatment. Individualization of method for each patient is essential in the attempt to obtain the best clinical results. It is difficult to keep in mind all the variations that have been described. For that reason a brief discussion on general points may be more practical.

In the treatment of cancer of the cervix we should first attempt to define the func-

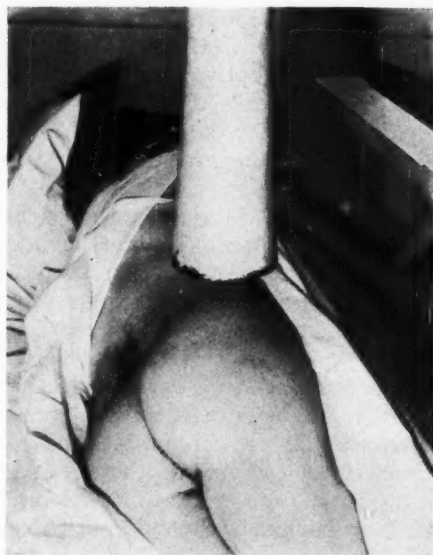


Fig. 2 For irradiation through gluteal fields, the patient lies in a trough, with belly flat against the side that makes a 60° angle with the horizontal.

tion of x-rays. It has been pointed out that, in most instances, roentgen treatment alone is inadequate for the destruction of the neoplasm. With the addition of radium, however, it is possible to increase the total volume of tissue adequately treated. Another important function of x-rays is the cleaning up of infection. Badly infected lesions tend to undergo necrosis after radium is applied, and there is evidence that infection also tends to increase radioresistance. On that basis one must conclude that the use of x-rays should precede radium treatment. Among early lesions that appear quite clean there may be the temptation to omit the use of external irradiation, but, as some of the speakers have shown, it is difficult to classify cervical cancer accurately. Furthermore, as pointed out by Dr. Stone, studies of iliac nodes have revealed remote metastases even in very early lesions. It seems obvious that, both from the standpoint of involvement and of infection present in varying degrees in all lesions, treatment of cancer of the cervix should always begin with x-rays.

This brings us to a consideration of doses. In cancer of the cervix there is considerable absorption of radiation between the skin and the tumor. If the daily dose applied to the skin is small, then the quantity arriving at the tumor may be insignificant. In some instances tumor recovery might be disadvantageous during treatment. It should also be noted that we may protract roentgen treatment over too great a period. During a course of x-rays there are several alterations produced in the tumor bed. If fibrosis and ischemia are excessive, there may then be greater radioresistance of residual tumor. Similar conditions may occur if the interval between x-ray and radium therapy is too great. It would seem best, therefore, to plan x-ray courses that would not be continued for too long a period, and in total amounts that would not delay the application of radium.

In regard to the optimum interval between the application of x-rays and radium, it seems worth while to mention observations on patients in whom there has been no rest period between the two methods. Probably all of us have met situations in which it became necessary for various reasons to give x-rays and radium more or less simultaneously. In our own experience this has happened not infrequently among those treated with needles. Clinical results in such cases have been quite satisfactory. This raises an interesting question for speculation. There may be some advantage in building up one maximum radiation effect from both x-rays and radium, rather than permitting recovery from roentgen irradiation before applying radium.

It has been most wholesome to hear this symposium. It has been presented in a manner that fulfills its purpose. We can feel that we have had a personal visit to the clinic of each of the essayists. The speakers are to be congratulated, and the program committee, too, is to be commended for arranging this unusual presentation of current problems and methods in the treatment of cervical cancer.

MAURICE LENZ, M.D. (New York): I should like to ask Dr. Cantril two questions. Did he say he gave 800 to 1,000 r per treatment on one or two occasions? Secondly, how long was the total period of treatment?

ROLLIN HOWARD STEVENS, M.D., (Detroit, Mich.): I should like to ask what the speakers mean when they say: "I think a cancer of the cervix cannot be cured without this technic," or without certain doses of x-ray.

I have just gone over some 393 cases of cancer of the cervix treated during the last fifteen years, and I do not show quite the percentage of five-year freedom from disease that Dr. Stone does. I get 24.6 per cent of "run-of-the-mine" patients who are well five years and over, but in the last year two of these returned with new cancers in other than the original site. One had gone nine years with no evidence of recurrence and the other eight years. In one a large carcinoma developed retroperitoneally in the region of and involving the 10th and 11th dorsal vertebrae; the other had a carcinoma of the ascending colon. Both patients had been examined regularly during those eight and nine years and there had been no evidence of recurrence. Were these patients cured of their original cancer and had they now another new cancer? Should we speak of five-year cures or five years' freedom from signs of cancer?

JOHN E. WIRTH, M.D. (Baltimore, Maryland): One impression given by the three papers is that x-ray treatment is minimized or may be omitted entirely in stage I cancer of the cervix.

A failure to cure 15 to 30 per cent of this group is admitted and is said to be due, in the majority of instances, to the fact that the disease was more extensive than could be determined clinically. X-ray treatment is strongly advised for the large number of stage II and stage III cases for the sake of an increase of 5 per cent, or at maximum 10 per cent, in the number

of five-year survivals. These two points of view do not seem entirely compatible to me. If it is so necessary to supplement radium with x-ray in stages II and III for a 5 to 10 per cent gain, why should it not be just as necessary in stage I cases?

HYMAN IRVING TEPERSON, M.D., (Brooklyn): I should like to ask a question as to the two lateral ports. Has there been any increase in decalcification of the head and neck of the femur as a result of the use of lateral ports? We have noticed cases where aseptic necrosis has occurred and also fissures due to pathologic fracture since we have used these ports.

L. HENRY GARLAND, M.D. (San Francisco, Calif.): I should like to ask Dr. Newell whether, if he had only 200-kv. radiation available, he would use three beams, as he is now doing and perhaps take a longer time; also whether he ever checks the centering of the gluteal ports.

ROBERT R. NEWELL, M.D. (*closing*): Dr. Stone's measurements, calculations, and clinical experience had indicated that the superiorities of supervoltage were not going to be perceptible if we stuck to the old technic. We thought there might be an advantage to supervoltage if we took into consideration what we knew was its only great point of superiority, namely: more x-ray going clear on through and less frittering away at the margins of the beam. That was why we tried the technic described.

Except for our wish to explore the possibilities of supervoltage, we would return to our previous almost total dependence upon radium. If we had only 200-kv. radiation we would not use three ports.

As to checking the centering of gluteal ports, I am continually at war with my young men because I find that the set-up is not within an inch or two of where it ought to be. That is one reason for not using smaller areas than we do. We have done a lot, mechanically, to set up

the method, but they will do their best to go wrong. If we wish an x-ray or radium treatment given to suit us, we have to give it ourselves.

The question has been asked why we use no perineal field. Our old experience had been that, due to scattering, the reaction in the perineum got ahead of the reaction in the middle of the belly. The other reason is that the radium is expected to take care of the cervical lesion; what we are asking of the x-ray is irradiation higher in the pelvis and the parametrium.

When we talk about cures, we do not know, of course, that they are cures. Patients come back many years later with recurrences. Let us talk about five-year or three-year survivals, just as a comparison of how much good we are doing. Dr. Stevens spoke about some 300 cases that he had treated and quoted his results. Let me say that we have about 600 cases, running back a long time, but since I am afraid my statistics are selected, I do not dare report them. About 50 per cent of the patients we have treated survived three years, but this includes all the earlier cases which were treated with radium alone. We know that we had less than 20 per cent five-year survivals when we were treating all stages solely with radium.

Dr. Wirth asked why x-ray therapy should not be added to the treatment of stage one cases. Heyman has reported that adding x-ray to his standard course of radium increased the good results only by the smallest percentage. It is hard on the patient to give her as much x-radiation as we do. We conclude that we had better stick to the cervix in irradiation when we hope the disease is really limited to that site.

About injuries to the neck and head of the femur when lateral fields are used—we have not seen any after the use of our three-quarter lateral (gluteal) fields.

Dr. Stone has shown that in stage I there is a good deal (25 per cent) of metastasis to nodes and that in later stages this is still greater. I note a remarkable similarity in the three-year survivals to

the percentage chance of node involvement. Is it possible that those that really do well are those in whom the nodes are not involved? Is it illusory to think that we are curing the disease after it has got into the lymph nodes? We know very well that in cancer of the lip, if the nodes of the neck are involved the patient cannot be cured by irradiating the neck with x-ray. If, however, only the lip is affected, we can cure the local lesion with 6,000 r. It may be that this is the case, also, with cancer of the cervix, and the only lucky ones are those that have no disease in the nodes. I don't know.

Dr. Cantril and I started from the same place and have gone in exactly opposite directions. He wants to use radium first and x-ray later, and I want to use x-ray first and radium second. Whether radium can be placed just as well at the end of the x-ray course should, I think, be investigated. I agree with Dr. Cantril that we ought not to do anything that seriously impedes the placement of radium, because the chance of success is going to depend almost wholly on that radium treatment.

Dr. Cantril does not wish to standardize. I want to point out that the anatomy is standard and the distribution of the disease is unknown from examination. Therefore, I use the standard treatment, since it is essential to treat the whole probable range of spread of the disease. We cannot afford to deviate treatment from the norm because in a particular case we believe one side to be more involved than the other.

ROBERT S. STONE, M.D. (*closing*): First, with regard to Dr. Newell's reference to the similarity of the survival rate and the number of possible metastases, I also noticed this when studying the statistics. The fact still stands that when radium was used alone the survival rate was much lower than when x-ray therapy was added. I do not claim that the patients are cured, but that they survive for five years. We have therefore done something to the metastases. Dr. Taussig's

removal of the nodes and the work being done by our own gynecologists show us that cancer cells are present in many of the nodes that are taken out. But what does it matter that cancer is there if the patient is going to live longer than with other methods of treatment previously employed? The mere fact that cancer is found should not deter us from treating such nodes in the pelvis any more than the fact that we cannot destroy metastatic nodes in the neck from cancer of the lip, which cannot be removed surgically, fails to deter us from treating them with x-rays. We know that x-rays shrink the enlarged neck nodes and that we have had patients living two, three, or more years with such nodes still palpable.

With regard to stage I cancer of the cervix, we treat all such patients with x-rays if they are not to have surgery. When a radical Wertheim type of removal is going to be done, there is no point in trying to treat the nodes, unless we believe that there is some value in preoperative treatment.

As to perineal treatment, I think Quimby's and Arneson's diagrams show us that the perineal port adds nothing to the uniform distribution of radiation in the pelvis. By using the fields, as we use them, we think that we give as much radiation in the depths as the tissues can stand. Using a perineal field is like using lateral fields on a small patient. They can be used but the amount given to the other fields must then be reduced so as not to overtreat the deep tissues.

With regard to the distortion shown in films made on the treatment apparatus, it must be remembered that one gets the same distortion in the treatments. The films show exactly the region through which the x-rays travel. We have tried to overcome such irregular interior distribution of the beam and hope that we are able to give a more uniform radiation by checking our direction with roentgenograms.

I think that aseptic necrosis of the head of the femur, when lateral ports are used,

while a risk, is a very slight one. We have not found it any more common in patients treated through lateral fields than in others. I believe in the original cases reported lateral fields were not employed. We found aseptic necrosis in one case in the body of the pubic bone of a patient who was irradiated. It was not discovered until necropsy. The same type of change was found as in the femur.

As to the question of using radium before or after the course of x-ray therapy, I will simply say this: The radium in our institution is placed by the gynecologists. I tried to persuade them to use x-rays first for the reasons quoted above. They said: "We have the patient on the operating table and are doing a biopsy and complete examination. Why isn't it better to place the radium for the first sitting at that time, after a frozen section diagnosis of cancer?" They are now thoroughly convinced that it is much easier for them to place the radium properly after x-ray treatment has been given, except in cases where the lesion is small at the start.

SIMEON T. CANTRIL, M.D. (*closing*): To

answer Dr. Lenz's question first, the protraction of our roentgen therapy has on the average been over a period of five to seven weeks. The daily dose is usually of the order of 400 to 500 r (measured on the skin). We have at times increased the daily dose to one field to as high as 800 to 1,000 r when, as mentioned in our paper, there have been indications for doing so. When due attention is given to the size of the field, these doses are well tolerated.

Our sequence of treatment is not routine, as in certain of our patients we do begin with roentgen therapy for one reason or another. I repeat, however, that when conditions permit we begin with radium therapy because we do not wish to jeopardize in any way a total dose of radium of at least 8,000 mg. hr.

I should rather believe that a standardization of radium and roentgen therapy in cancer of the cervix can never be to the best interests of the patient. The wide variation of pathologic anatomy which one encounters requires an adaptation of the treatment to the disease at hand, and for that reason we aim at individualization rather than standardization.

A STATISTICAL AND ROENTGEN ANALYSIS OF TWO HUNDRED CASES OF BONE AND JOINT TUBERCULOSIS¹

By LOUIS NATHANSON, M.D., M Sc. (Med.), and WILLIAM COHEN, M.D., Brooklyn, N. Y.

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A REVIEW of a large series of cases of verified bone and joint tuberculosis has impressed us with the unusual and varied roentgen findings. In many instances the roentgenographic appearance of the lesion has been so at variance with the criteria commonly accepted as evidence of bone and joint tuberculosis that it is our opinion that a roentgen diagnosis is not only difficult but in many instances inconclusive. A knowledge of the clinical course and general condition of the patient is indispensable in arriving at an accurate interpretation, and frequently histologic studies are the only means of reaching a positive diagnosis.

Two hundred cases of bone and joint tuberculosis were chosen at random from the vast amount of material available at Sea View Hospital. The tuberculous nature of the disease process was verified in each instance. The cases were equally distributed between the pediatric and adult services of the institution, there being one hundred in each group. Patients under the age of sixteen were included in the former group, those sixteen and over in the latter.

STATISTICAL STUDY

Age Incidence.—In the age group one to sixteen there appears to be a natural division into two subgroups, between the years nine and ten (Table I). Of the 100 cases, 70 were in the one to ten year subgroup and 30 in the ten to sixteen year subgroup. This predominance in the early age group is true of both sexes. Seventy-five per cent of the cases in males and 65 per cent of those in females occurred during these years. In the female sex there is again a definite rise in incidence at fifteen

years. This may be attributed to the effects of puberty. Whether this predominance in younger children is to be attributed to the initiation of active bone disease during an early post-primary hematogenous dissemination, or to the reactivation of a focus previously deposited, is a debatable question. In view of the fact that 28 patients presented definite roentgen evidence of a fresh or resolving primary pulmonary lesion (Table V) it is probable that the osseous involvement was initiated during and progressed from the time of early post-primary dissemination.

In the adult group of cases, the ages ranged from sixteen to seventy years. As is apparent from the accompanying table (Table I), the frequency with which bone tuberculosis occurs in the various adult subgroups corresponds to those ages at which physical activity is most strenuous and pulmonary tuberculosis most prevalent. From sixteen to twenty the number of cases approximates that in the pediatric group. Immediately thereafter, twenty to twenty-five, there is an abrupt rise to the maximum incidence, followed by a gradual decline till the subgroup forty to forty-five is reached. At this point, which marks the division between the adult and old age subgroups, there is a sudden and distinct drop in incidence. Of 100 cases, 77 occurred between the ages of sixteen and forty-five, whereas after the age of forty-five there were only 23. This decreased incidence in later life is true of both sexes. Seventy-six per cent of the cases in females and 77 per cent of those in males occurred between the ages of sixteen and forty-five.

Sex Incidence.—Of the 100 cases in the age group one to sixteen, 45 were in males and 55 in females (Table I). The ratio

¹ Accepted for publication in April, 1940.

TABLE I.—DISTRIBUTION OF CASES ACCORDING TO AGE, SEX, AND RACE

Age	Males					Females					Total Males and Females
	White	Negro	Porto Rican	Oriental	Total	White	Negro	Porto Rican	Oriental	Total	
Pedi- atric Group											
1		3	1		4	2				2	6
2	1	2			3	3	2	1		6	9
3	1	1			2	3	3	1		7	9
4	2	2	2		6	4				4	10
5	1	3	1		5	1	1			2	7
6	2	1			3	1	1	2		4	7
7			2		2	2				2	4
8		4		1	5	2	4			6	11
9	2	1	1		4	3				3	7
10	1		1		2			2		2	4
11						2	2			4	4
12		1			1	1	1			2	3
13	1	1			2	1	2			3	5
14	2				2	1	1			2	4
15	2	1			3	2	2			4	7
16				1	1	1	1			2	3
Total	15	20	8	2	45	29	20	6		55	100
Adult Group											
16-20	2	2			4	2	1	1		4	8
20-25	5	6	2		13	4	2			6	19
25-30	6	4	2		12		2			2	14
30-35	6	2	1	1	10	2	2			4	14
35-40	9			1	10	1	1			2	12
40-45	8	1			9		1			1	10
45-50	3				3	2	1			3	6
50-55	4				4	1	1			2	6
55-60	6				6						6
60-65	3				3						3
65-70		1			1	1				1	2
Total	52	16	5	2	75	13	11	1		25	100

of male to female children in the institution at the present is 1:1. Thus, from this series of cases, it appears that bone tuberculosis is slightly more prevalent in the female than in the male child.

In the adult group of 100 cases, there were 75 males and 25 females, a ratio of 3:1. Since the ratio of male to female adults in the institution is at present 2:1, bone tuberculosis was half again as prevalent in the male as in the female adult.

Race Incidence.—Of the younger patients—one to sixteen—44 were white, 40 colored, 14 Porto Rican, and 2 oriental (Table I). The ratio between white and colored cases is 1.1:1. This does not correspond to the ratio of 1:1.4, which is the present ratio between white and colored children in the institution, and indicates that there is a somewhat greater preva-

lence of bone tuberculosis in white children. Among the male cases, however, the ratio of white to colored children is slightly less than the prevailing ratio in the institution, 1:1.3 and 1:1.1, respectively; in the female cases, much greater, the figures being 1.5:1 and 1:1.8, respectively. It is apparent from this series of 100 cases that bone tuberculosis is slightly more common in colored male children than in white male children, and much more prevalent in white than in colored female children.

In the adult group, 65 patients were white, 27 colored, 6 Porto Rican, and 2 oriental. The ratio of white to colored adults is 2.4:1, as compared to a ratio of white to colored adults in the institution of 3:1. This shows a slightly greater prevalence of bone tuberculosis in the colored than in the white adult. This is true of

both sexes in approximately the same degree.

Distribution of Osseous Lesions.—The distribution of the osseous lesions is shown in Table II. In the age group one to six-

TABLE II.—COMPARATIVE DISTRIBUTION OF OSSEOUS LESIONS IN THE PEDIATRIC AND ADULT GROUPS

Location of Lesion	Pediatric Group 1-16 years	Adult Group 16-70 years
Spine	57	52
Cervical	1	
Dorsal	37	18
Lumbar	14	15
Cervico-dorsal	2	2
Dorso-lumbar	2	14
Lumbo-sacral	2	3
Hip joint	21	18
Knee joint	3	11
Ankle joint	1	3
Shoulder joint		1
Elbow joint	9	4
Wrist joint	1	1
Metacarpals	17	1
Carpals	1	2
Metatarsals	8	1
Tarsals	12	5
Sacro-iliac joint	6	15
Phalanges	14	
Ribs	7	8
Sternum	1	2
Clavicle		1
Scapula	1	
Mandible	1	
Frontal	1	
Zygoma		1
Orbit	1	
Trochanter of femur	1	2
Humerus	1	
Radius	1	
Tibia	1	
Fibula	1	
Pubis	1	1
Symphysis pubis		1

teen, the most striking feature is that of a total of 100 patients 57 showed disease in some area of the spine, either as a single lesion or in conjunction with other osseous involvement. This exceeds, by far, the frequency with which any other area was involved: the hip joint in 21 cases; metacarpals, 17; phalanges, 14; tarsals, 12; elbow joint, 9; metatarsals, 8; ribs, 7; sacro-iliac joint, 6; knee joint, 3. Other areas were involved in isolated cases.

Of 100 patients in the sixteen to seventy age group, 52 showed spine involvement, either as a single lesion or in combination with other osseous involvement. Again, as in the pediatric group, this far exceeds

the frequency with which other areas were affected: hip joint, 18; sacro-iliac joint, 15; knee joint, 11; ribs, 8; tarsals, 5; elbow joint, 4; ankle joint, 3. Other areas were involved less frequently.

In the adult group there is a definite predominance of bone and joint tuberculosis in the weight-bearing areas as compared to the upper extremities and the non-weight-bearing areas. This is well illustrated by the frequency, in the order named, with which the spine, hip, sacro-iliac, knee, and ankle joints are involved as contrasted to the relative infrequency of disease in the non-weight-bearing areas, as the shoulder, elbow and wrist joints, carpals, metacarpals, phalanges, and skull. In the pediatric group, the same predominance exists. It is less marked, however, than in the adult group, and manifests itself only in the frequency of spine and hip joint involvement. In the younger group a decided prevalence of disease in the small tubular bones of the hands and feet is noticed. These were involved infrequently in the adult age group. Thus the metacarpals, phalanges, tarsals, and metatarsals were affected 17, 14, 12, and 8 times, respectively, in the one to sixteen year group, while the corresponding figures for the sixteen to seventy year group were 1, 0, 5, and 1. Furthermore, the sacro-iliac and knee joints were diseased in 6 and 3 instances, respectively, in the younger group, whereas the same areas were affected in 15 and 11 of the older patients.

This discrepancy in localization between the younger and older age groups we believe is explainable by two factors. The osseous disease process may be initiated at the time of deposition of tubercle bacillus *via* the blood stream. On the other hand, a focus of infection which is thus created may remain dormant for an indefinite period. Following a decrease in local resistance, such as may occur with trauma, or a generalized reduction in resistance, the dormant focus is capable of reactivation with the initiation of progressive disease. In either event, the original

focus of infection is deposited during hematogenous dissemination, whether it be in the early, post-primary phase, or at a later date. In adult life, physical exertion is greatest. Those areas constantly subjected to the strain of weight-bearing are *loci minoris resistentiae*. A focus of infection which has remained dormant for some time may become reactivated by the constant trauma to which it is thus subjected. In childhood, on the other hand, weight-bearing plays a less important rôle. Here the active disease process is initiated at the time of deposition of the tubercle bacillus; the latent period, if present at all, is short. These considerations do not, however, preclude the possibility of a relative latent period for a focus of infection reactivated by trauma during childhood, or the immediate initiation of active disease in adult life due to a sporadic hematogenous dissemination from an extra-osseous focus.

Tuberculosis of the ribs is usually secondary to spinal involvement. Extension of infection from a paravertebral abscess plays a prominent rôle. In the adult group, 6 of the 8 cases of rib tuberculosis were associated with spine tuberculosis. In the younger group, 3 of the 7 cases occurred in combination with spine lesions.

Tuberculosis of the skull is a relatively infrequent finding. In this series, there were 3 instances in the pediatric group and 1 in the adult group.

Interestingly enough, all the cases in which the shafts of long bones were involved occurred in the one to sixteen year group. There were 4 such instances. The humerus, radius, tibia, and fibula were the sites of localization.

Distribution of Vertebral Involvement (Chart 1).—Generally speaking, the extremities of the spine are infrequently involved. In no instance was the coccyx or the first or second cervical vertebra affected. The most frequent sites of involvement were the dorsal and lumbar areas, particularly from the sixth dorsal vertebra to and including the fifth lumbar body. The upper dorsal spine was rarely

involved in the adult group, but more frequently in the one to sixteen year group. On the other hand, lesions in the lower dorsal spine, from the ninth through the twelfth dorsal vertebrae, were much more frequent in the adult than in the pediatric group.

In this series the average number of vertebral bodies involved per case was 3.85 in the adult group and 2.93 in the younger patients.

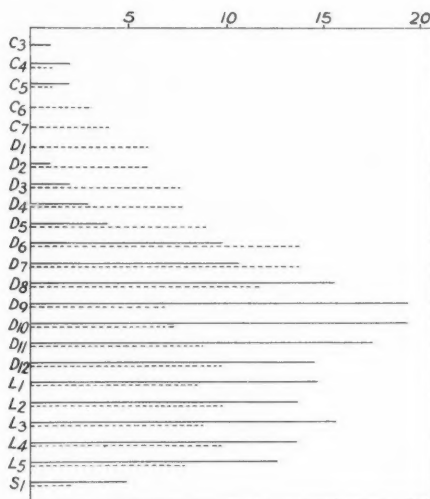


Chart 1. Distribution of vertebral involvement. The average number of vertebrae involved is 3.85 per adult case, 2.93 per pediatric case. Solid lines represent adult group, broken lines pediatric cases.

Skipped infection of the vertebral bodies was not an uncommon finding. In most instances a paravertebral abscess was visualized, extending from one area of involvement to the other. Ten such cases are included in the series. Nine of these occurred in adult patients, of whom 7 had demonstrable paravertebral abscesses. The other case was in the one to sixteen year group and also presented a paravertebral abscess.

Multiple Osseous Involvement (Tables III and IV).—Involvement of more than one area was a common finding. It occurred somewhat more frequently in the pediatric than in the adult group. Thirty-

TABLE III.—DISTRIBUTION OF MULTIPLE OSSEOUS LESIONS

(Multiple crosses represent bilateral or multiple involvement. Rib involvement is considered as a single lesion whether one or more ribs are involved. Phalangeal, carpal, and tarsal lesions are considered multiple only when more than one extremity is involved.)

Name	Sex, Age and Race	Spine	Elbow	Wrist	Sternum	Metacarpals	Phalanges	Hip	Sacro-iliac	Knee	Ankle	Tarsus	Metatarsus	Symphysis	Pubis	Ribs	Humerus	Frontal	Femur	Tibia	Radius	Zygoma	Clavicle	Pulmonary Pathology	Evidence of Hematogenous Dissemination
<i>Pediatric Group</i>																									
G.G.	M. 21 mos. N																							Primary infiltrating Infiltration on left	Lupus vulgaris; lichen scrofulosorum
E.H.	M. 5. N		+			+		+								+								Multiple cold abscesses of skin	
J.E.	F. 6. W		+			+	+				+													Miliary tonsillar lesions	
G. H.	F. 11. W		+			+	+		+															Miliary lung lesions. Bilateral pleural effusion	
J.I.	F. 3. N		+																						
J.P.	F. 3. W		+														+								
D.T.	M. 6. N	+																							
T.T.	M. 13. N	+																		+				Infiltration on right Infiltration on right Infiltration on right	
G.P.	F. 3. N						+					+				+									
L.F.	M. 15. N			+																					
G.C.	M. 4. PR					+																		Pleural effusion Genito-urinary and peritoneal tuberculosis	
R.B.	F. 12. N	+							+																
J.R.	M. 14. W	+						+																Tuberculous meningitis	
M.M.	M. 12. N	+							+															Pleural effusion	
B.V.	F. 10. PR	+			+																			Tubercules	
M.C.	F. 2. W					+	+					+													
G.P.	F. 2. N					+	+																		
J.C.	M. 9. W	+								+															
B.C.	F. 13. W							+																	
E.W.	F. 8. N	+						+																	
J.P.	M. 5. PR	+										+												Root infiltration	
U.F.	F. 15. N	+														+								Caseous pneumonia	
S.L.	M. 8. O	+										+				+		+						Infiltration on right	
M.O.	F. 3. W	+														+								Miliary tuberculosis	
A.S.	F. 14. N	+							+							+								Tuberculides	
A.D.	F. 14. W	+														+								Multiple cold abscesses of skin	

[illegible]

TABLE IV.—NUMBER OF CASES WITH SINGLE AND MULTIPLE AREAS OF INVOLVEMENT AND NUMBER OF AREAS INVOLVED

Pediatric group (1-16 years).....	100 cases
Single involvement.....	65 cases
Multiple involvement.....	35 cases
Two areas.....	21
Three areas.....	5
Four areas.....	2
Five areas.....	2
Six areas.....	3
Seven areas.....	2
Adult group (16-70 years).....	100 cases
Single involvement.....	72 cases
Multiple involvement.....	28 cases
Two areas.....	22
Three areas.....	5
Four areas.....	1

five per cent of the former and 28 per cent of the latter showed multiple involvement. In no instance in the adult group were more than four areas involved; in the one to sixteen year group, 7 such cases were observed. The greatest number of areas affected in any one case was seven. This occurred in two instances.

*Complicating Conditions (Tables V and VI).—*It is generally stated that osseous and pulmonary tuberculosis do not commonly occur together. In this series the reverse is true. Of 100 patients in the one to sixteen year group, 42 presented pulmonary tuberculous infiltrations. Of this number 28 were fresh or resolving primary infections, while 14 were reinfections. In 3 instances miliary pulmonary tuberculosis was present in addition to one of the above types. Nine of the 42 patients had positive sputum, and in 3 of these pneumothorax therapy was instituted. One of the latter developed a tuberculous empyema. Of the 9 patients with positive sputum, 5 had gastro-intestinal tuberculosis and one tuberculosis of the larynx.

Of the 100 adult patients, 55 had pulmonary tuberculous infiltration. Caseous pneumonic infiltration was present in 21 cases, exudative in 7, productive in 24, miliary in 4, while 2 patients had typical chronic hematogenous tuberculosis. In a few instances more than one type of infiltration was demonstrated. Twenty-four of these 55 patients had positive sputum,

TABLE V.—PULMONARY INVOLVEMENT WITH BONE TUBERCULOSIS*

Pediatric group (1-16 years).....	100 cases
Pulmonary lesions.....	42 cases
Reinfection type.....	14
Fresh or resolving primary type.....	28
Miliary.....	3
Adult group (16-70 years).....	100 cases
Pulmonary lesions.....	55 cases
Caseous pneumonia.....	21
Exudative.....	7
Productive.....	24
Miliary.....	4
Chronic hematogenous.....	2

* In certain cases more than one type lesion was present, i.e., a miliary lesion superimposed on another previous type lesion.

and pneumothorax therapy was initiated in 9 of these. Four of the latter developed tuberculous empyema. Of the patients with positive sputum, 15 developed gastro-intestinal tuberculosis and 7 laryngeal tuberculosis.

Pleural effusions frequently accompanied osseous tuberculosis in this series. There were 10 cases in the one to sixteen year group. Four of these occurred in the presence of spine involvement. In the adult group 17 patients had pleural effusions. In 11 these accompanied spine tuberculosis. Whether the effusion is due to the contiguity of the pleura to the paravertebral abscess in those cases with spine tuberculosis, or is merely another manifestation of hematogenous dissemination, is a matter for conjecture.

A number of other complicating conditions occurred, all of them manifestations of hematogenous dissemination. These included tuberculosis of the meninges, genito-urinary system, peritoneum, eye, and skin. The latter two areas were involved only in the one to sixteen year group.

Amyloidosis is a frequent and a serious complication of osseous tuberculosis, occurring more frequently than in the pulmonary type of the disease or than in tuberculous empyema. Seventeen per cent of the pediatric group and 19 per cent of the adult group presented this complication.

Single isolated cases of tuberculous involvement of the cervix, liver, and breast were found in the adult group.

TABLE VI.—COMPLICATING CONDITIONS IN THE PEDIATRIC AND THE ADULT GROUP

	Pediatric Group 1-16 years	Adult Group 16-70 years
Paravertebral abscess	28	37
Pleural effusion	10	17
Unilateral	8	13
Bilateral	2	4
Parenchymal pulmonary involvement	42	55
Positive sputum	9	24
Negative sputum	91	76
Without pulmonary pathology	58	45
With pulmonary pathology	33	31
Pneumothorax	3	9
Empyema	1	4
Amyloidosis	17	19
Tuberculous meningitis	3	4
Tuberculous peritonitis	7	4
Genito-urinary tuberculosis	2	15
Laryngeal tuberculosis	1	7
Gastro-intestinal tuberculosis	5	15
Miliary tuberculosis	3	4
Ischiorectal abscess	2	5
Multiple cold abscesses of skin	6	6
Tuberculosis of eye	10	
Phlyctenular keratitis	3	
Phlyctenular conjunctivitis	6	
Choroid tubercles	1	
Dermal tuberculosis	17	
Tuberculosis verrucosa cutis	1	
Scrofuloderma	5	
Lupus vulgaris	2	
Lichen scrofulosorum	1	
Papulonecrotic tubercule	8	
Tuberculosis of cervix		1
Tuberculosis of liver		1
Tuberculosis of breast		1

ROENTGEN DIAGNOSIS

It is not our intention to enter into a general discussion of the diagnosis of bone and joint tuberculosis or to attempt a differential diagnosis from other lesions, since the literature on the subject is voluminous and rather complete. We wish, however, to stress certain diagnostic criteria based upon our daily routine interpretations and an analysis of the material reviewed here. It is our impression that many misconceptions exist and that hard and fast rules are frequently applied that do not always hold true. One frequently hears statements to the effect that bone and joint tuberculosis is a purely destructive lesion and that, when bone production

is present, a secondary infection or an infected sinus tract probably exists; that joint tuberculosis is nearly always a mono-articular disease; that the joint space is rapidly or even primarily involved in all cases of Pott's disease. These and other statements of a similar nature may be true in a large percentage of cases, but the departures are so frequent that they must be considered more than mere exceptions to the rule.

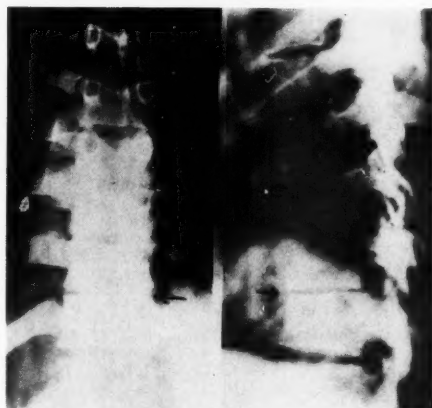


Fig. 1. Extensive cold abscess. Note narrowing of interspace with no apparent osseous involvement.

Paravertebral Abscess.—The presence of a paravertebral abscess is frequently demonstrated in spine tuberculosis. In this series, it was present (Table VI) in 28 of the 57 cases with spine involvement in the one to sixteen year group (49.1 per cent) and in 37 of the 52 cases in the adult group (71.3 per cent). The paravertebral swelling may be the only manifestation of tuberculous disease of the spine; that is, the only sign that can be demonstrated roentgenographically. Although we recognize the fact that an underlying bone lesion is present, there may either be insufficient destruction, or the type of tuberculous infiltration present may be of such a character (productive infiltration in most instances), that it cannot always be visualized by means of the roentgenogram (Fig. 1). Furthermore, the intervertebral disc may be involved with no

narrowing of the intervertebral space or irregularity of the body of the vertebrae to indicate the presence of osseous disease. These are not infrequent findings at necropsy, where definite and extensive bone destruction has been found though the roentgenogram taken shortly before death showed only the presence of a paravertebral abscess, and even a postmortem roentgenogram of the involved spine removed from the cadaver failed to show any evidence of bone destruction. This has been noticed particularly in those in-

of the dorsal spine (Fig. 2). This propensity of the paravertebral abscess to dissecting extension may lead it into regions far removed from its site of origin. As shown by Cohen and Taylor (2), "a cold abscess from a caries of the dorsal spine may extend upward to discharge its contents on the surface at the base of the neck; it may gravitate downward to point beneath the medial attachment of Poupart's ligament or it may dissect its way laterally and then anteriorly, external to the endothoracic fascia and parietal

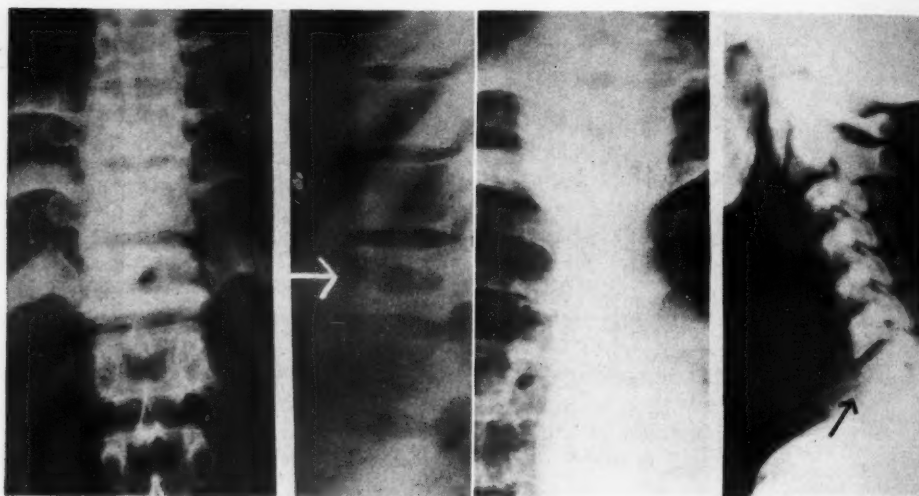


Fig. 2. Central lesion, without involvement of interspaces. Note extent of abscess.

Fig. 3. Cold abscess simulating a mediastinal tumor; prevertebral swelling. Visualized in lateral view of cervical region.

stances where the anterior surfaces of a number of vertebral bodies have been eroded by an overlying abscess, or where an area of the primarily productive type of tuberculous infiltration was present.

The paravertebral abscess may be bilateral or may remain in great part unilateral. It may be localized to the region of bone destruction, or it may extend for a considerable distance above and below, showing very little if any dependence on gravity for its spread. We have frequently demonstrated extension throughout the dorsal spine area of an abscess which originated from a focus in the lower portion

pleura, to point in various regions of the thoracic cage or secondarily erode the contiguous ribs, and even involve the sternum. . . ."

In the cervical region the paravertebral abscess can be first and best visualized on the lateral roentgenogram (Fig. 3). In this position the bulging of the retropharyngeal and retrotracheal tissues is almost pathognomonic of abscess. The cervical abscess may gravitate through the superior aperture of the thoracic cage where, on the routine chest roentgenogram, it simulates a superior mediastinal mass (Fig. 3).

In the lumbar region, the cold abscess

fuses with the shadows of the psoas muscle. Not uncommonly it can be visualized in a lateral exposure, lying anterior to the vertebral bodies and extending downward into the pelvis. With chronicity, varying amounts of calcareous material are deposited in the abscess (Fig. 8). This aids visualization, especially in the lateral roentgenogram.

With extensive abscess formation, not uncommonly there is seen generalized indentation of the anterior surface of the underlying vertebral bodies, not unlike

from one involved area to the other. This occurred in 8 of the 10 cases with skipped infection. It is our impression that many of these skipped infections are examples of contiguous spread of the disease process by an extending cold abscess and not of separate embolic foci. It is highly probable that the skipped vertebral bodies, which appear roentgenographically to be uninvolved, actually are affected, but not in a manner that can be shown on the roentgenogram as it is commonly taken today. This was noticed in a number of



Fig. 4. Central type lesion, showing cupping of vertebrae and calcification in abscess.



Fig. 5. Skipped vertebral involvement.

the cupping associated with aneurysm of the aorta. This condition is found particularly in the dorsal region and is probably due to the transmitted pulsations of the thoracic aorta upon the abscess (Fig. 4).

Involvement of separated areas of the vertebral column, or skipped infection, is not rare. Of the 109 cases in this series in which the spine was affected, 10 (9.2 per cent) presented this type of involvement (Fig. 5). Interestingly enough, in a great majority of the cases a paravertebral abscess was visualized extending

instances at necropsy. On the roentgenogram the vertebral bodies intervening between two well separated and distinct areas of destruction appeared to be uninvolved by all the present-day criteria; but at autopsy, the anterior surfaces of these same vertebral bodies were found to be eroded by an overlying paravertebral abscess which extended from the upper to the lower area of involvement, and often beyond. This does not, however, preclude the possibility of multiple embolic foci in the vertebral column.



Fig. 6. Marginal localization of tuberculous lesion, interspace involved.

of spine tuberculosis should not be attempted by an interpretation of the roentgenogram alone, but rather by a complete evaluation of all the facts pertaining to each case.

Localization of Vertebral Involvement.—

From an analysis of the material in this study, we have found that any part of the vertebral body may be involved. The pathologic process may originate in and be limited, roentgenographically, to the anterior, posterior, or central portion of the vertebral body, or about its margins. This selective localization is dependent upon the age of the patient and the condition of the blood supply to the part. Rarely are the small parts of the vertebrae affected. When such involvement does occur, in isolated instances, it is usually

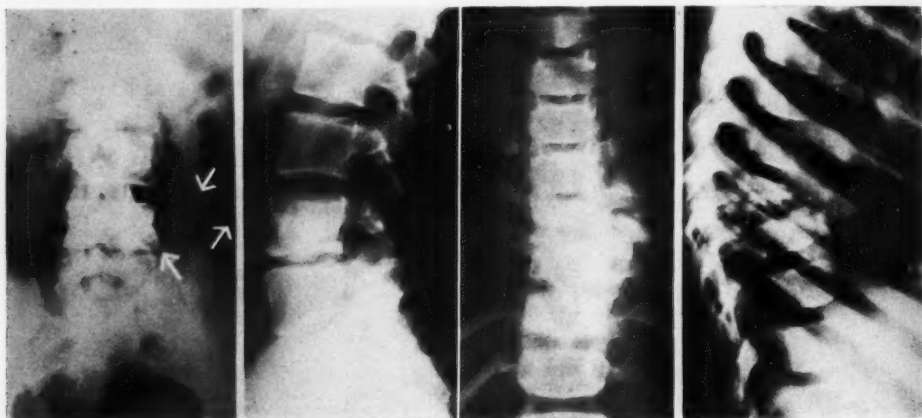


Fig. 7. Involvement of anterior inferior margin. Arrows indicate pathology and outline of cold abscess.

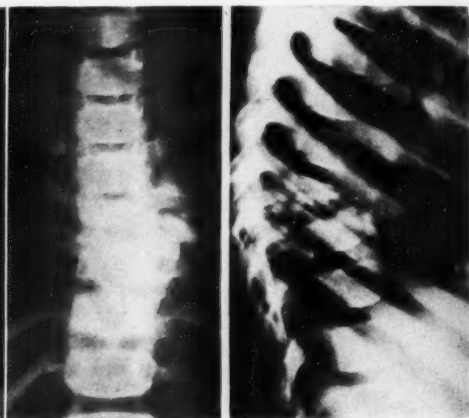


Fig. 8. Central lesion. Note calcification in abscess anterior to spine.

Paravertebral swellings are usually considered pathognomonic of spine tuberculosis. In a tuberculosis institution, this holds true in a great preponderance of cases. Such swellings may occur, however, with other diseases of the spinal column, notably tumors of the spinal cord. The frequency with which soft tissue swellings occur with tumors of the cord, a fact which is well recognized in neurological institutions, lends force to the contention of the authors that the diagnosis

secondary to a spreading cold abscess or to a primary involvement of some other portion of the vertebral body (Fig. 11).

Marginal localization of the tuberculous process in disease of the vertebral body occurs more frequently in the adult than in the younger age group (Fig. 6). In this type of involvement the intervertebral disc is commonly affected secondarily, giving rise to the narrowed interspace so typical of Pott's disease. While any portion of the margins may be affected, the



Fig. 9. Posterior involvement of body.



Fig. 10. Productive lesions. Central lesion. Interspaces uninvolved.

anterior inferior margin is a rather frequent site (Fig. 7). Any tendency toward collapse of the vertebral body is a late manifestation and denotes progression of the destructive process beyond the original confines of the disease. It has been suggested that the proximity of the marginal lesion to the periosteum is the etiological basis for the pain so common in adult spine tuberculosis, even in the absence of collapse or marked destruction of the vertebral body. In the younger age group the lesion is most frequently of a central

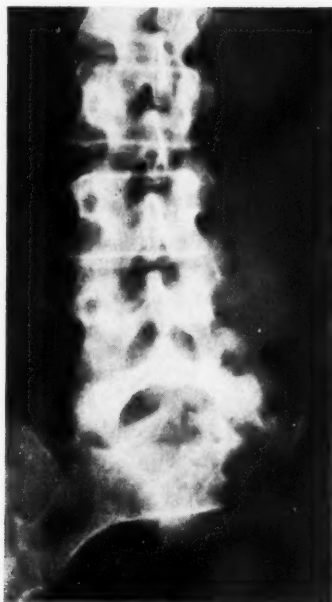
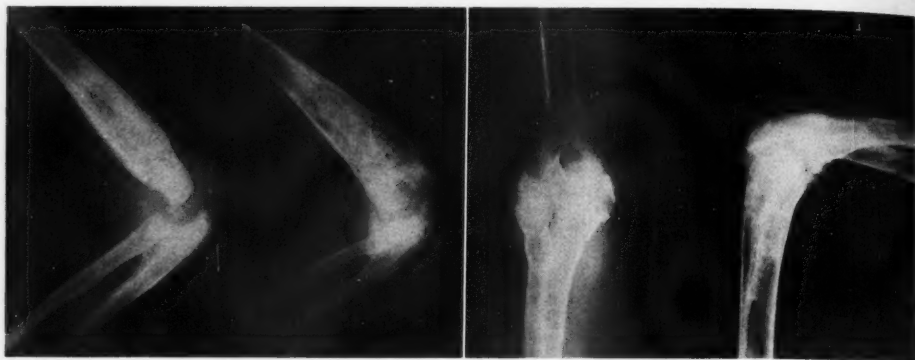


Fig. 11. Localized involvement of articular process. No evidence of body involvement.

type (Fig. 8), and the first manifestation may be deformity and collapse of the vertebrae rather than pain, which is a late manifestation.

The central type of involvement of the vertebral body does not occur as frequently as the marginal form. It is most prevalent in the very early age groups. At times the entire center of the body may be affected, with rapid and complete dissolution; gibbus formation is then pronounced. Where the lesion is confined to the center (Fig. 2), involvement of the intervertebral disc with narrowing of the intervertebral space does not commonly occur. This has been noticed even in the presence of beginning collapse of the vertebral body. Lesions limited to the anterior or posterior portions of the body show the same finding. This emphasizes the point that intervertebral disc involvement with narrowing of the intervertebral space as a manifestation of early spine tuberculosis is dependent upon the primary site of the disease process.

The posterior portion of the vertebral



Figs. 12 and 13. Shaft involvement secondary to joint involvement. Fig. 13 (right) shows the parallel arrangement of the periosteal reaction in shaft involvement.



Fig. 14. Punched-out lesions involving the greater trochanter secondary to membranous involvement.

Fig. 15. Multiple shaft involvement: tibia, radius, first metacarpal, and femur.

body is by far the most infrequent of the sites previously mentioned for localization of a tuberculous process (Fig. 9). In this location the infection may give rise to an external pachymeningitis secondary to a cold abscess or due to direct extension of the lesion to the spinal cord.

In the great majority of cases, whatever the location of the lesion, destructive changes predominate. In some instances, however, productive changes with little or no evidence of destructive changes are present (Fig. 10). This has been demonstrated in several lesions of the central type and in the absence of any secondary non-tuberculous infection.

Shaft Tuberculosis.—Primary involvement of the shaft of a long bone is rela-

tively uncommon in children and a rare lesion in the adult. There is nothing in this type of lesion that is characteristic of osseous tuberculosis. The disease may simulate a diffuse chronic non-specific osteomyelitis or appear as a punched-out cystic type of lesion. The shaft is frequently involved secondary to joint tuberculosis, particularly where the lesion has been allowed to progress to any great extent (Figs. 12 and 13). In such cases the roentgen appearance of the shaft cannot be differentiated from a non-specific chronic osteomyelitis. Irregular periostitis frequently develops about the shaft, which may become ballooned out and show irregular punched-out areas suggesting cystic changes. Contrary to the com-



Fig. 16. Bilateral symmetrical cystic lesions of os calci.



Fig. 17. Punched-out lesions in skull, shown by arrows.

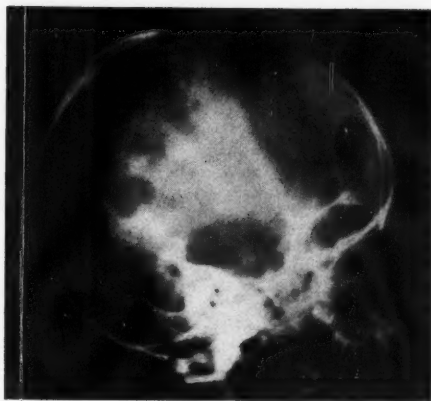


Fig. 18. Punched-out mottled lesion in skull.

monly accepted dictum that osseous tuberculosis is purely a destructive disease, considerable productive bone reaction may develop about these rarefied areas. The productive periostitis is nearly always parallel to the shaft, as in a non-tuberculous infection, in contradistinction to the perpendicular sun ray formation seen in primary bone malignancy (Fig. 13). At times, the periostitis may assume an irregular perpendicular arrangement about the margins. Nevertheless, the involvement of the shaft secondary to a neighboring joint is highly suggestive of the tuberculous nature of the entire process.

In two instances a punched-out area was demonstrated involving the greater trochanter of the femur. The lesions were secondary to overlying membrane involvement and the diagnosis was made after biopsy (Fig. 14).

Although the primary tuberculous shaft lesion is rare, in one instance this type of involvement occurred in four distinct tubular bones, all without joint involvement, namely the femur, tibia, radius, and metacarpal bones. The different types of tuberculous osteomyelitis are demonstrated in this one case (Fig. 15).²

Tuberculosis of the shaft of short tubular bones is a frequent finding in children. It is a rare lesion in the adult. In this

series, there were thirty-nine such areas affected in the one to sixteen age group, whereas in the adult group there were only two examples, one in a metacarpal and the other in a metatarsal bone (Table II). There was no instance of phalangeal involvement in the adult group. As in similar disease of the shaft of long bones, the roentgen appearance is not characteristic. Destructive and productive changes may be present with or without a marked productive periostitis (Fig. 15-B). Frequently the lesion is predominantly cystic in appearance (Fig. 16). Soft tissue swelling about the lesion is almost always present.

Membranous bones are seldom involved by a tuberculous process. When they are so affected, the lesion is as a rule an isolated one and is usually visualized as a circumscribed area of rarefaction. This is

² This case is not included in the statistics of this series. It was discovered after the series had been chosen and analyzed.



Fig. 19. Irregular punched-out area involving lower end of humerus.

particularly true in tuberculosis of the skull and ilium (Figs. 17 and 18). The diagnosis cannot be established with any degree of certainty except by biopsy or in conjunction with positive findings elsewhere. Similar punched-out and cystic areas occur in tuberculosis of the ribs. In these instances, the roentgen appearance is dissimilar to the rib lesions secondary to contiguity with a paravertebral tuberculous abscess. Here the margins of the ribs and occasionally the shafts are eroded.

Joint Tuberculosis.—The subject of joint tuberculosis has been covered so extensively and with such detail in the literature (3, 4, 5, 6, 7, 10, 11, 12, etc.) that there is little to add. We have been impressed, however, by the number of cases in which punched-out areas were visualized in the shaft immediately adjacent to the involved joint. This occurred about the shoulder, knee, ankle, and especially the elbow joint (Fig. 19). So outstanding



Fig. 20. Large kidney-shaped cold abscess about hip secondary to hip-joint involvement. Injected opaque media smeared out in soft tissue.

was this finding that we feel it to be almost characteristic of tuberculosis of the joints named. The soft tissue swellings about a joint should always be taken into consideration in the interpretation of joint pathology. Figure 20 shows a large kidney-shaped swelling about the hip joint and indicates the size which a peri-articular abscess may reach.

Bilateral Symmetrical Lesions.—A number of examples of bilateral symmetrical tuberculous involvement (Figs. 16, 21, 22) have been seen in the material entering Sea View Hospital. This distribution of lesions is of no importance except for its rarity and interest. It does, however, emphasize the hematogenous nature of bone and joint tuberculosis.

SUMMARY

1. Two hundred cases of verified bone and joint tuberculosis were analyzed. These were chosen at random from the pediatric and adult services of Sea View Hospital. Each group consisted of 100 cases.

2. All patients up to sixteen years of age were included in the pediatric group. Seventy per cent of this group were less than ten years old. All patients of sixteen and over were included in the adult group. The oldest patient in this group was seventy years of age. Seventy-seven per cent of the adult cases occurred be-



Fig. 21. Bilateral sacro-iliac joint involvement.



Fig. 22. Bilateral clavicular involvement.

tween the ages of sixteen and forty-five, and this percentage was approximately the same for both sexes.

3. In this series, bone and joint tuberculosis occurred somewhat oftener in the female than in the male child and was half again as frequent in the male as in the female adult. The incidence was slightly higher in colored male children than in white male children and much higher in white female children than in colored female children. Colored adults, both male and female, showed a slight predominance in the number of cases over white adults. The prevailing ratio of male to female patients and of colored and white patients in the institution was taken into consideration.

4. The spinal column was involved to a much greater extent than any other area. This was true both in the pediatric and in the adult group. The frequency with which weight-bearing areas were involved in the adult group, in contradistinction to the infrequency of non-weight-bearing areas, and the high incidence of small tubular bone disease in the pediatric group, as compared to its marked in-



Fig. 23. Tuberculous arthritis of left hip. Possible Perthes disease on right side.

frequency in the adult group, are discussed. The influence of trauma on latent foci in the adult group and the immediate effects of an early post-primary hematogenous dissemination in the pediatric group are suggested as possible explanations for these findings.

5. The upper dorsal spine was much more frequently involved in the one to sixteen age group than in the adult group. The reverse was true of the lower dorsal

spine. Skipped infections of the vertebral bodies were not uncommon.

6. In contradistinction to the commonly accepted belief that bone and joint tuberculosis is a monoarticular disease, 35 per cent of the pediatric cases and 28 per cent of the adult cases showed involvement of more than one area. The greatest number of areas affected was seven, among the pediatric cases.

7. In this series, 42 per cent of the pediatric cases and 55 per cent of the adult cases showed some form of pulmonary tuberculous infiltration. This high incidence is contrary to the view commonly held. Other important and frequently occurring complications were pleural effusions, genito-urinary tuberculosis, tuberculous peritonitis, tuberculous meningitis, and amyloidosis.

8. A paravertebral abscess was demonstrated in 28 of the 57 spine cases (49.1 per cent) in the pediatric group and in 37 of the 52 spine cases (71.3 per cent) in the adult group. The abscess may be the only roentgen evidence of underlying bone disease. Its extension is not dependent upon gravity alone. Calcareous material is frequently deposited in paravertebral abscesses of long duration. Skipped infection of vertebral bodies may be due to the extension of a paravertebral abscess in addition to multiple embolic foci. Paravertebral swellings occur in conditions of the spine other than tuberculosis.

9. The vertebral body may be primarily involved in its anterior, central, or posterior portions, in addition to its margins. The small parts of the vertebrae are infrequently involved and such involvement is usually secondary to disease in one of the above named areas. Marginal involvement occurs most frequently in adults and is usually associated with narrowing of the intervertebral disc. Pain is common, but collapse of the body is a late manifestation of the disease process. The central type of lesion is found chiefly in young children. Collapse of the body occurs early in the disease but pain and narrowing of the intervertebral space are

later manifestations. Posterior involvement is more frequently associated with clinical evidence of cord involvement than lesions producing marked collapse of vertebral bodies with kyphosis and gibbus formation. In this type of involvement, as well as the central and anterior form, the intervertebral space is not necessarily narrowed.

10. Primary shaft tuberculosis is relatively uncommon in children, but involvement of the short tubular bones is frequent. Both are rare in adults. Shaft tuberculosis secondary to joint involvement is not infrequent. The roentgen appearance is not typical of tuberculosis alone. There is a resemblance to chronic non-specific osteomyelitis with productive and destructive changes and an overlying periostitis.

11. Tuberculous lesions of membranous bones usually appear as punched-out areas, and the diagnosis can be made with certainty only by biopsy or in conjunction with positive findings elsewhere.

12. Punched-out lesions were observed in the shaft of long bones immediately adjacent to tuberculosis of the shoulder, knee, ankle, and especially the elbow joint. So frequent was this finding that we consider it a valuable aid in diagnosis.

13. Bilateral symmetrical lesions were observed and serve to indicate the hematogenous character of involvement.

14. Finally, bone and joint tuberculosis may resemble so many other osseous lesions that its diagnosis should not be attempted from the roentgenogram without a detailed knowledge of all the clinical facts pertaining to each case as an individual problem.

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A ROENTGENOGRAPHIC STUDY OF PLEURAL EFFUSION¹

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ALTHOUGH the pleural effusions and empyemas which complicate pulmonary tuberculosis appear similar in the roentgenograms to those found in other types of pleural disease, the course, frequency, ultimate results, and treatment are not comparable. The effusions developing in tuberculous patients have been studied in detail from laboratory and clinical as-

and physical findings always vary, major emphasis has been placed upon a study of the roentgenograms and minor emphasis upon the clinical data and laboratory reports, except for necropsy findings.

Between the years 1919 and 1938, inclusive, 5,731 patients were admitted to Glen Lake Sanatorium for treatment of tuberculosis. Of this group, 233 patients without previous thoracentesis had pleural effusions; in 125 of these effusions developed in the Institution, in 108 they occurred prior to admission. None of these patients showed any evidence of spontaneous pneumothorax.

The effusions were present on the right side in 103 cases, on the left side in 117, and on both sides in 13. Since 54 per cent of the patients were females, and females accounted for 52 per cent of the total admissions, there was no sex preponderance. The age distribution corresponded to the age distribution of the total admissions. The average age of the patients in both groups was about thirty years, and about one-half of all patients were in the third decade (Fig. 1).

In 20 of the 233 patients with pleural effusions, tuberculosis, although suspected, was not proved (9 per cent), and although pulmonary lesions were not demonstrable in an additional 9 (4 per cent) the effusions were associated with tuberculous paravertebral abscesses in 3 of these (1 per cent) and tuberculous peritonitis in 6 (3 per cent). The stage of pulmonary tuberculosis was undetermined in 3 (1 per cent). Three patients (1 per cent) had primary tuberculosis, 35 (15 per cent) minimal lesions, 80 (34 per cent) moderately advanced disease, and 83 (36 per cent) far advanced pulmonary tuberculosis. Among the total admissions were 5,389 patients

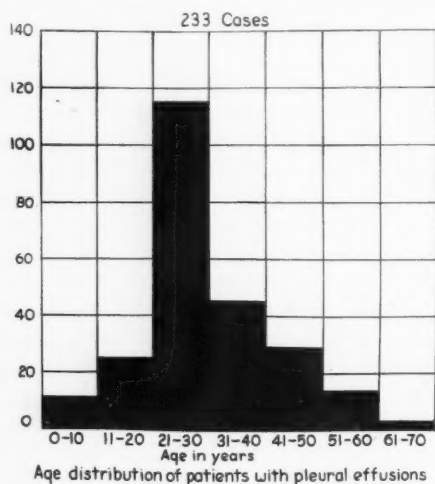


Fig. 1.

pects, but neglected from the roentgenologic standpoint. This study was undertaken to correlate spontaneous pleural effusions with the various stages of chronic pulmonary tuberculosis, and also to determine the relative frequency of this condition in the different age and sex groups, the roentgenologic type, and the subsequent course.

Because interpretations of symptoms

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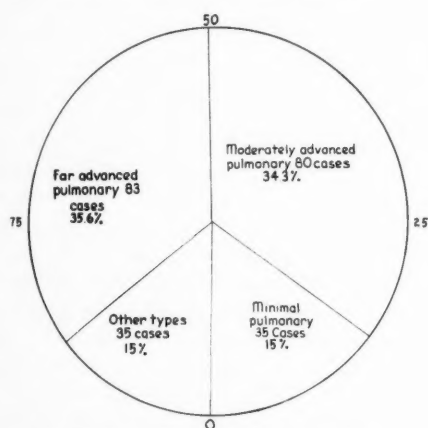
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with pulmonary tuberculosis, and of this number 3,016 (55.97 per cent) had far advanced disease, 1,526 (28.32 per cent) moderately advanced disease, and 499 (9.26 per cent) had minimal disease; 339 (6.29 per cent) had childhood tuberculosis and in 9 (0.16 per cent) the stage was undetermined (Figs. 2 and 3). Thus, it is evident that pleural effusions form more often in the presence of minimal and moderately advanced disease than in far advanced cases.

The apparent duration of tuberculosis previous to the development of the effusions varied from one month to nine years, the average being thirteen months. The

in 148. The lower portion of the lung was covered in 50, and the interlobar fissure was widened in 37. The fissure most frequently involved was the one separating the upper and middle lobes of the right lung. Displacement of the heart occurred in 10 cases. In addition, 21 of the 26 effusions present in the bilateral cases were typical.

In the upright roentgenogram, effusions of less than 400 c.c. cannot be detected (Ganter, 2). The fluid collects first in the posterior costophrenic sinus, which is 6 cm. below the dome of the diaphragm (Sante, 9). The increasing fluid then fills the anterior costophrenic sinus and obliter-

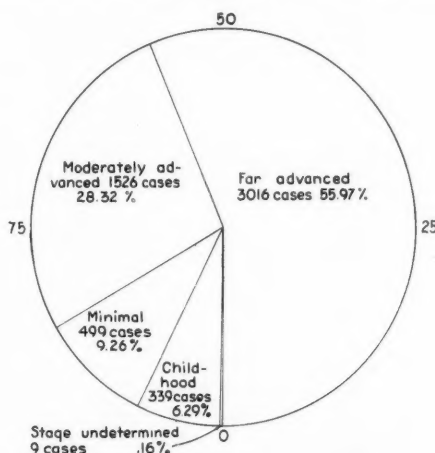


Tuberculous disease in 233 effusions

Fig. 2.

duration of the effusion, determined from the history, varied from two days to one year, with an average duration in all cases of two months. In 58 per cent, the symptoms resulting from the pleural effusion were present two weeks to two months previous to roentgenographic study.

The 220 patients with unilateral effusions were classified in six groups. Roentgenographic studies showed that in the first group, those with typical effusion, there were 172 patients. The fluid remained localized to the costophrenic angle in one instance, extended so as to obliterate the diaphragm in 23, and extended up the lateral border of the lung to the axilla



5389 Patients admitted with pulmonary tuberculosis through the same period 1919-1938

Fig. 3.

ates the costophrenic angle. A further increase in the amount of the fluid causes an opacity which spreads medially over the dome of the diaphragm, obscuring it, and then extends up the lateral margin of the lung border to the axilla. A still further increase of fluid produces an opacity covering the lower portion of the lung and renders visualization of the pulmonary markings impossible.

In children, the opacity often extends as a thin ribbon along the lateral chest wall, reaching to the apex (Stewart, 10). The border of the opacity is concave and is

higher on the lateral lung margin than on the medial. At the base of the lung the shadow is dense, while above this there is a layer of varying density, through which some of the pulmonary markings may be seen. In this simple effusion, Kaunitz (3) describes three roentgenologic zones which merge into one another; the lowermost or radio-opaque area consisting entirely of liquid displacing the lung from the chest wall; the middle or radio-translucent

side in every patient of this group. Occasionally the diaphragm was pushed down and the ribs were spread apart. Frequently the opacity was so dense that the lung, diaphragm, ribs, and heart could not be visualized. Five effusions in the bilateral group were massive. Four cases of the typical and one of the mediastinal type of effusion developed into the massive type while under observation.

In the third group, the mediastinal pleural effusion, there were 3 cases. In this type, most of the fluid accumulates in the mediastinal pleural space inferiorly, with little or no fluid around the lateral border of the lung. On the upright roentgenogram, the appearance may be confused with that seen in pericardial effusion, mediastinal tumor, paravertebral abscess of the thoracic spine, atelectasis of the lower or accessory lobe, enlarged mediastinal glands, or if in the upper portion of the pleural cavity, a substernal thyroid.

There were 2 cases in the fourth group, in which the upper border of the liquid was convex and could be interpreted readily as an elevated diaphragm. This simulates somewhat the picture seen after a phrenic nerve interruption or elevation of the diaphragm such as might be caused by a subphrenic abscess on the right side.

The fifth group also comprised 2 cases. The upper border of the liquid was horizontal in the upright position, even though no free air was present in the pleural cavity. This picture is seen after aspiration of fluid and the introduction of air, but in these cases aspiration had not been done.

There were no cases in the sixth group, the last one, in which free fluid in the pleural space simulates an encapsulated effusion in the interlobar fissure. Rigler (7) has shown that when the upper border of the fluid reaches the interlobar fissure, it is drawn in by the force of capillarity and occasionally appears on the roentgenogram as an encapsulated effusion, even though the fluid is in free communication with the pleural space.

Groups III, IV, V, and VI (Fig. 4) may

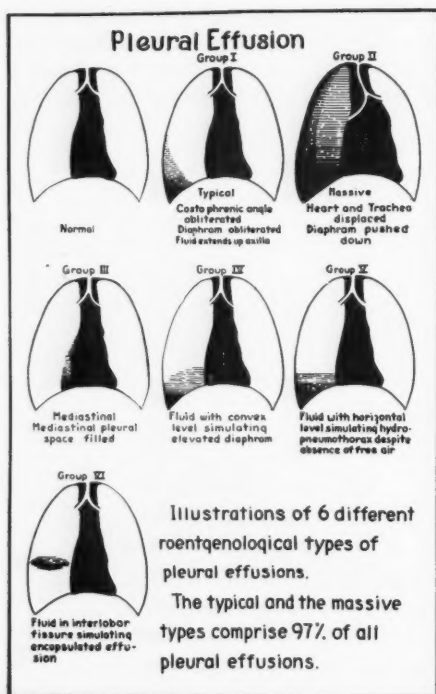


Fig. 4.

zone, representing a moderate amount of liquid separating the lung from the chest wall; the uppermost or transparent area, representing a film of liquid too thin to cast a roentgenographic shadow.

The second group of cases, massive pleural effusion, numbered 41. The entire lung field was obliterated by an opacity which sometimes was lighter in the apical and infraclavicular regions. The heart, trachea, and other mediastinal structures were displaced toward the contralateral

be termed the atypical pleural effusions, and in these groups, a change in position of the patient is most helpful in obtaining a correct diagnosis.

It has been shown by the roentgen studies of Rigler (8), Lenk (5), Polgár (6), and others, that liquid in a free pleural space shifts with a change in position of the patient. In several instances of atypical pleural effusions in this series, a definite diagnosis could be made only after studying roentgenograms of the patient made in various positions. The method is especially helpful in differentiating between a large paravertebral abscess in known cases of tuberculosis of the thoracic spine and a mediastinal pleural effusion.

of effusion comprised 97 per cent of the total.

In 197 patients of the entire group, the roentgenograms at the time of the effusion were satisfactory for an analysis of the predominant type of pulmonary tuberculosis and the presence of cavitation. In the remaining 36 the pulmonary lesion was hidden by the effusion and the stage of tuberculosis was determined after resolution of the effusion, following aspiration, or at necropsy.

The type of pulmonary tuberculosis was classified on an anatomical roentgenological basis. The terms "exudative," "proliferative," and "infiltrative" were not used simply because they imply micro-

TABLE I.—ROENTGEN TYPES OF PLEURAL EFFUSION (233 CASES)

	Typical	Massive	Mediastinal	Horizontal Fluid Level	Convex Fluid Level	Total Cases
UNILATERAL						
Not aspirated	97	9	3	2	0	111
Aspirated	75	32	0	0	2	109
Total	172	41	3	2	2	220
BILATERAL						
Not aspirated (6 cases)	11	1				6
Aspirated (7 cases)	10	4				7
Total	21	5				13

If, after the upright roentgenogram, the patient is placed in the supine position, the fluid distributes itself over the entire lung between its posterior surface and the chest wall. In the Trendelenburg position, the fluid shifts and covers the apex and the upper part of the lung field, exposing the costophrenic angle, the diaphragm, and the lower part of the lung. In the lateral decubital position with the affected side down, the liquid distributes itself along the lateral costal gutter, parallel to the long axis of the chest, and the medial portion of the lung field is exposed. In the lateral decubital position with the affected side up, the liquid shifts into the mediastinal gutter, leaving the costophrenic angle, the lateral portion of the diaphragm, the lateral costal gutter, and the lateral portion of the lung field all clear.

Table I shows the distribution of the roentgenologic types of effusion in the entire series. The typical and the massive types

scopic diagnosis. Instead the pulmonary lesion was classified as being "predominantly nodular," "fibrotic," "cavernous," "pneumonic," "calcified," or "miliary." In most instances, of course, the roentgenogram showed more than one type of pulmonary lesion, but in all cases the predominant type was chosen. There was a group of childhood pulmonary tuberculosis and also a group in which the lungs were normal.

The type of pulmonary tuberculosis present at the time of the effusion was nodular in 73 (36 per cent), fibrotic in 60 (30 per cent), cavernous in 18 (9 per cent), pneumonic in 9 (5 per cent), calcified in 3 (1.5 per cent), and childhood or normal chest in 32 (16 per cent). There were no instances of miliary tuberculosis.

The nodular and fibrotic types accounted for two-thirds of the series. The nodular type was present in only 6 per cent more than the fibrotic; in necropsy reports,

however, the nodular type is the predominant one in about 80 per cent. The exact significance of this is undetermined. The percentage of effusions in the presence of cavernous, pneumonic, and calcified lesions was about as would be expected. The infrequent occurrence of pleural effusions in the presence of miliary tuberculosis has been noted by others (Rigler, personal communication). Whether this is due to the fact that the patient expires before the tubercles have enlarged sufficiently to rupture the pleura cannot be stated.

Cavitation was present on the same side as the effusion in 34 cases, on both sides in 20, and on the opposite side in 12 cases. Effusions occurred almost three times as

duration of the tuberculosis, the type of distribution of effusion, the roentgen type of pulmonary lesion, and resolution.

The sex and age distribution was the same in both groups, and the associated pulmonary tuberculosis was about equal in both, except that in the aspirated group there were 17 cases of suspected tuberculosis, as compared to 3 in the non-aspirated group. The duration of the disease was about the same in both groups. Table II shows the associated pulmonary tuberculosis in both groups.

The roentgen type of pulmonary tuberculous lesion was essentially the same in both groups. The nodular type predominated slightly in each, and the fibrotic

TABLE II.—CORRELATION OF EFFUSION WITH TUBERCULOUS DISEASE

	Far Ad- vanced Pul- monary Tuber- culosis	Moder- ately Ad- vanced Pul- monary Tuber- culosis	Mini- mal Pul- monary Tuber- culosis	Sus- pected Tuber- culosis	Tuber- culous Pari- tonitis	Child- hood Tuber- culosis	Tuber- culous Spine	Tuber- culosis Un- deter- mined
Not aspirated (117 cases)	44	39	18	3	5	3	3	2
Aspirated (116 cases)	39	41	17	17	1			1
Total (233 cases)	83	80	35	20	6	3	3	3

frequently in the presence of cavitation on the same side as when cavitation was present on the opposite side. In many patients cavitation developed sometime after the occurrence of the pleural effusion.

Subsequent studies were made on 190 cases. Of the remaining 43 patients, 20 had been lost and the other 23 had been discharged from the Institution within the past eighteen months, which was considered the minimal time of study. Of the 190 patients, 100 were living and 90 were dead. Of the latter group, 52 or 58 per cent died within one year after hospitalization. Of those alive, 76 or 76 per cent had been living for more than five years.

The total group of 233 patients was split into two: one group of 117 patients in whom aspiration was not done, the other of 116 patients from whom fluid was aspirated one or more times. The two groups were compared as to age distribution, associated pulmonary tuberculosis,

type followed closely in second place. There was a dissimilarity in the roentgen type of distribution of the effusion, the subsequent course, and the resolution of both groups.

The group which was aspirated had more fluid present in the pleural cavity. There were 32 cases of the massive type in this group as compared to 9 in the non-aspirated group (Table I). Also, in general, the fluid extended up higher, obliterating more of the lung fields (33 times as compared with 20 times in the non-aspirated group). To a certain extent, the amount of fluid present determines the symptoms and it is probable that in the aspirated group, in which more fluid was present, the symptoms were more severe, indicating aspiration, as compared with the non-aspirated group.

In the group of 190 patients with complete subsequent records, 100 had been aspirated and 90 had not. Of the 100

aspirated patients, 48 (48 per cent) were known to be dead and 33 had died within one year after hospitalization. In the non-aspirated group of 90, 32 (35 per cent) were known to be dead, and only 18 had died within one year after hospitalization. All the factors in the two groups were approximately equal except that there was more fluid present in the aspirated group, and it seems that the amount of fluid present to some extent determined the prognosis. Among patients with a large amount of fluid the mortality was in general greater than among those with less.

Pleural fluid from 27 of 98 patients produced tuberculosis when inoculated into guinea-pigs. Careful studies were done on

Roentgenograms were available for 72 of the non-aspirated group. In this group 31 showed complete resolution and 41 incomplete. Complete resolution had occurred in 19 of the 31 patients (60 per cent) within two years. In the aspirated group, roentgenograms of 66 patients showed complete resolution in 10 and incomplete resolution in 56. Complete resolution in 6 of the 10 (60 per cent) occurred within two years, also.

Table III shows the stage of the tuberculous disease correlated with the resolution for both groups, and it is evident that the stage of the pulmonary disease does not greatly influence the percentage of complete resolution in either. In the non-

TABLE III.—STAGE OF TUBERCULOSIS CORRELATED WITH RESOLUTION OF THE PLEURAL EFFUSION (138 CASES)

	Far Advanced Pulmonary Tuberculosis	Moderately Advanced Pulmonary Tuberculosis	Minimal Pulmonary Tuberculosis	Suspected Tuberculosis	Tuberculous Peritonitis
CASES ASPIRATED (66)					
Complete resolution (10 cases)	2	4	3	1	
Incomplete resolution (56 cases)	14	21	10	10	1
Percentage showing complete resolution	12.4%	16.0%	23.0%	9%	
CASES NOT ASPIRATED (72)					
Complete resolution (31 cases)	9	10	7	3	2
Incomplete resolution (41 cases)	14	15	11	1	
Percentage showing complete resolution	39.0%	40.0%	38.8%	80%	

the pleural fluid in 69 of the aspirated cases. The cell count of the fluid in 41 cases (60 per cent) was below 2,000 cells per c. mm.; in only one was it above 10,000 cells.

Subsequent roentgenograms were included in 138 records. These were arbitrarily grouped as follows: (1) those one to two years following the initial effusion; (2) those two to five years following the effusion; (3) those five years or more after the effusion. No patient was placed in more than one group, and all were placed in the oldest group possible. The roentgenograms were all examined for evidence of the previous effusion and the following points were noted: obliteration of the costophrenic angle by adhesions, irregularity of the diaphragm such as "tenting" or "straightening," thickening of the pleura, and widening of the interlobar fissure.

aspirated group, the percentage of complete resolution, regardless of the stage of the tuberculosis, was about twice as great as in the aspirated group. The reason for this cannot be stated definitely. Burnand (1) thinks that the trauma incident to pneumothorax or the presence of gas in the pleural space is sufficient to cause pleural symphysis after cessation of the pneumothorax. While the presence of some air in the pleural space following aspiration is a common occurrence, still in none of these cases was a pneumothorax permanently established. Leifer (4) found that in 50 cases of pleural effusion, repeated aspiration reduced adhesion formation.

The most common finding in the cases with incomplete resolution was obliteration of the costophrenic angle by adhesions; this was present in 93 per cent of both groups. Pleural thickening was present in

about 75 per cent of both groups, distortion of the diaphragm in about 30 per cent, and widening of the interlobar fissure in 10 per cent. In practically all of the cases, some resolution gradually occurred over a period of years. The most permanent finding and the last to disappear was obliteration of the costophrenic angle.

CONCLUSIONS

1. The age and the sex distribution of 233 patients with pleural effusion was approximately the same as in routine admissions for pulmonary tuberculosis.

2. Effusions occurred more frequently in the presence of less pulmonary tuberculosis than was seen in the general admissions.

3. The typical and the massive types of effusion comprised 97 per cent of the entire group studied.

4. The nodular and the fibrotic types of associated pulmonary tuberculosis were the predominant ones in about 75 per cent.

5. Cavitation was three times as frequent on the side of the effusion as on the opposite side.

6. Cases in which a large amount of fluid was present, in general, had a somewhat poorer prognosis.

7. The resolution of the effusion was independent of the associated pulmonary tuberculosis.

8. In 60 per cent of the cases with complete resolution, this occurred within two years.

9. Cases in which a large amount of fluid was present and aspiration performed, did not show as complete resolution as those in which less fluid was present and aspiration was not done.

10. The most common and the most permanent roentgen finding in the cases without complete resolution was obliteration of the costophrenic angle.

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MEGA-ESOPHAGUS (CARDIOSPASM)

REPORT OF A CASE WITH SUBDIAPHRAGMATIC HERNIATION OF THE ESOPHAGUS

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THE enlarged esophagus without an organic stenosis has been reported in medical literature under many different names. Some of these connote its etiology, such as cardiospasm, esophagismus, phrenospasm, and achalasia of the cardia. Others refer to the gross anatomical changes, such as idiopathic dilatation of the esophagus, mega-esophagus, and esophagectasia.

Until the latter part of the nineteenth century this type of esophageal lesion was considered a pathological curiosity. Some of the earlier cases were reported by Baillie (1), in 1797, Purton (2), in 1828, and Rokitsky (3), in 1846, but they believed the condition to be of rare occurrence. Soon after the report by Zenker and Ziemssen (4), in 1877, of 17 cases of esophageal obstruction without cause, there began to appear case reports in which the diagnosis was made before death. Meltzer (5) is credited by Einhorn (6) with having been one of the first to make a diagnosis in the living (1888). About 1882 Mikulicz (7, 8) began to use an improved, longer esophagoscope originally described by Rosenheim (4), and in 1904 estimated that over a hundred cases could be collected from medical literature. Gottstein (9) in 1908 stated that over 120 cases had been reported and that he had seen an additional 25. In the same year Plummer (10) reported 40 cases, and in 1921 Plummer and Vinson (11) published a series of 301 cases. Sturtevant (12) wrote that 20 cases were diagnosed in the Department of Hospitals in the City of New York in the year 1930. The lesion is generally recognized to-day and is not infrequently seen in a large hospital practice.

DIAGNOSIS

The history and diagnosis of cardiospasm are described in many standard medical texts (13, 14, 15, 16) and will not be discussed here except to mention some observations of particular interest to the roentgenologist. The findings vary somewhat with the duration of the disease. In cases of several months' standing there is a compensatory hypertrophy of the esophageal wall and a deep constricting peristalsis is seen when contrast media are in the esophagus. Deep peristaltic waves occurring at different levels and varying in their depth give the appearance of a writhing, twisting esophagus. Often a quantity of food residue is present, which can readily be recognized by the movability of irregular, translucent areas. The lowermost end of the dilated esophagus has a blunted smooth outline that has been aptly termed cigar-shaped. Sometimes the ending is pouch-like because of a deviation or slight angulation to the right, and in such cases the narrowed opening is eccentrically located on the left side at varying heights above the most dependent portion of the pouch, which makes it difficult to pass dilating instruments or bougies through the cardia.

The differential diagnosis of lesions of the lower end of the esophagus is not always easy. Some observations which can be used to advantage will be discussed. The lower end of the esophagus normally has a movement synchronous with and produced by the heart beat. Also, as originally pointed out by Cannon (17), there is a movement due to respiration. Both movements are easily seen by fluoroscopy and with a bougie in the cardia they can be felt. Also they can be shown by

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roentgen kymography. The absence of the normal movement is suggestive of an infiltrative neoplasm or fixation by paraesophageal inflammation. A primary squamous cell epithelioma may be present with cardiospasm (18). A neoplasm without spasm in the upper two-thirds of the esophagus rarely, if ever, causes dilatation. Dilatation may occur, however, from spasm alone (19, 20). In carcinoma of the esophagus an opening usually remains through which a stream of barium mixture readily passes, whereas in cardiospasm the barium column, as a rule, is abruptly stopped for some time. Later it can be seen to flow out in intermittent jets accompanied by vigorous peristalsis from the hypertrophied, dilated walls above the obstruction.

ETIOLOGY

The most probable cause of cardiospasm is sympathetic nerve fiber stimulation of cortical origin or reflexly from a visceral lesion. The history of most cases discloses a severe psychic trauma, a blow to the chest, or a visceral lesion such as pneumonia or peptic ulcer. Stimulation of either the vagi (21, 22) or the sympathetic fibers extending along the left gastric artery produces a contraction of the cardia (23). Section of both vagi in either the cat or dog produces the functional equivalent of cardiospasm (24, 25), which in some cases is apparently overcome in a few days but in others is lasting. Knight and Adamson (23) have shown that the functional obstruction of the cardia from section of both vagi is relieved if the sympathetics accompanying the left gastric artery are also sectioned. The excised esophagus shows a peristaltic wave through its distal extremity when it is stimulated mechanically by pinching or distention (26). This is believed to be a myenteric reflex from Auerbach's ganglia (26). Although the distal extremity of the esophagus does not have, either macroscopically or microscopically, the anatomical structure of a sphincter (27), it does have a functional sphincter. In prolonged cardiospasm the

cardia has a thickened wall not unlike a pyloric sphincter (see case report).

It is difficult to be certain about the etiological factors in a lesion apparently produced by stimulation of the sympathetic nerve fibers. Many opinions have been expressed regarding the cause of cardiospasm. Some believed it had a mechanical origin, such as a contracted liver tunnel (28), contractural bands (29), pinching by the diaphragm crus (30, 31), or angulation above the hiatus (32). Other suggestions included esophagismus (33) or infection of contiguous structures (34). A congenital defect in development of the nerve or muscle has been mentioned (35).

Hurst (36) suggested failure of relaxation of the cardia as the etiological factor. In several publications he has emphasized the point that the lesion is not one of spasm (37, 38). To replace the latter term he introduced (36) the designation "achalasia" (*a*, not; *χαλαω*, to relax). The authors believe the term "cardiospasm," suggested by Meltzer and Mikulicz is descriptive and applicable.

Rake (39, 40), Cameron (41), and Lendrum (27) have reported the histological findings in fatal cases of cardiospasm as consisting of marked leukocytic infiltration of the mucosa, submucosa, and muscular layers, with destruction of the myenteric ganglia. Since then Hurst has suggested that the lesions in the myenteric plexus are the etiological factors in failure of relaxation of the cardia. Kraus (42) had previously suggested that the lesion might be due to degeneration of the vagus nerve. Degenerative, inflammatory lesions, such as ileitis, in other segments of the gastro-intestinal tract, which have a similar muscular arrangement and a myenteric plexus (43, 44), do not produce an obstruction similar to cardiospasm. If cardiospasm is the result of destruction of the myenteric ganglia, it is difficult to explain the cases of spontaneous remission and its occurrence in the new born (48). Cardiospasm is perhaps sometimes due to irritation of the vagus nerve but in the

majority of cases it is probably the result of sympathetic nerve stimulation.

TREATMENT

The curative treatment of cardiospasm is by forcible dilatation. A break in the sympathetic neuromuscular mechanism appears to be the means of obtaining results. The first curative treatment was done by Mikulicz (7, 45), by sticking his finger, through a gastrostomy opening, into the cardia and forcibly dilating it. Sometimes he used forceps blades instead of his finger and he suggested that a dilating instrument should be devised for this purpose (7). In 1898 Russell (46) described a hydrostatic bag which he used in 7 cases seen by him over a period of eleven years. He emphasized the necessity of forcible dilatation to obtain cures and showed how this could be done through the esophagus and without the necessity of a gastrostomy. His method of treatment, with some modifications, has been successfully used ever since (10, 15).

Forcible dilatation of the cardia through the esophagus can be easily done with a metal dilator, which has some advantages over the hydrostatic bag (13, 47). The metal dilator constructed and used by one of us (A. C. C.) for this purpose has a spreading mechanism controlled by a lever. The resistance of the esophageal wall against the spreader is transmitted through the lever to the hand of the operator. When the spreader is opened in the area of spasm, the operator can feel the sudden disruption of the contracted muscle fibers and immediately relax his pressure on the lever so as to avoid rupture of the lining mucous membrane or complete rupture of the wall.

Operative procedures on the cardia by transpleural (49) and transperitoneal routes (50) have been done in cases which were unsuccessfully treated through the esophagus. These were usually cases in which the dilating instrument could not be inserted through the area of spasm. Sometimes the operation consisted of an incision through the muscular coats, similar

to the Rammstedt operation for hypertrophic pyloric stenosis; in other instances a plastic procedure was employed, not unlike a pyloroplasty (51). Esophagogastrostomies have been done in some instances (52, 53), as by Dr. Whipple in the case to be reported here. Since the publication by Knight and Adamson (23) of the results obtained from resection of the sympathetic fibers from the celiac ganglion which accompany the left gastric artery, several reports (54, 55, 56) of this operation have appeared. Some of the cases treated in this manner were not completely relieved and later required dilatation through the esophagus. This may have been because all the sympathetic fibers to the cardia were not removed along with the gastric artery, or possibly due, in part, to a certain amount of fibrosis following long-standing cardiospasm. It is of interest that the simple passage of a bougie completed the cure in some cases following the sympathetic nerve resection.

CASE REPORT

The following case appears to be unusual in that the esophagus herniated through the hiatus into the abdominal cavity.

The patient was a male student nineteen years of age, who said that his illness had begun about two and a half years earlier. A few weeks before the onset of this illness he had graduated from high school as valedictorian of his class. Two weeks later his grandmother, of whom he was very fond, died, and her loss he stated had affected him more than he thought it should. He had apparently planned and discussed his future with her more than with his parents.

The first symptom was described as "food sticking in the esophagus." This the patient tried to correct by drinking a lot of water with his meals, but the condition grew worse. Within a few weeks he gave up solid food and took only liquids and semisolids. Even so he was continually bothered by a sensation of pressure beneath the sternum and at times by a feeling of suffocation. He obtained relief

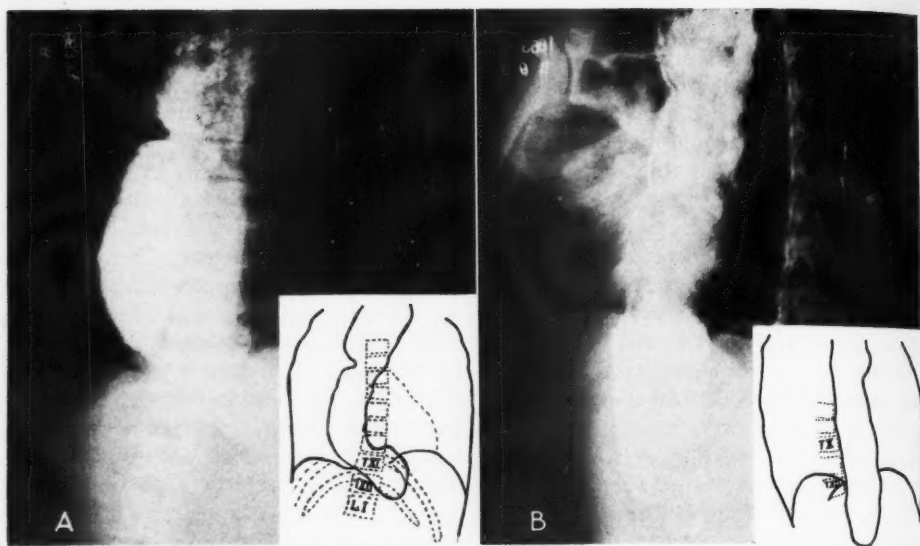


Fig. 1. Anteroposterior (A) and oblique (B) views of esophagus containing food residue, taken shortly after a swallow of barium. In the oblique view it can be seen that the dilated esophagus extends well below the diaphragm.

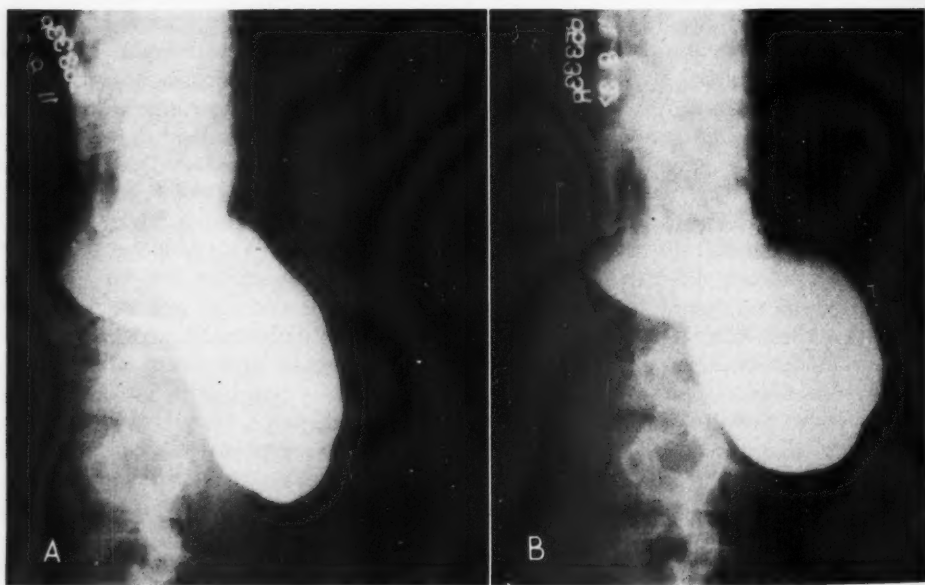


Fig. 2. Oblique views of the esophagus after lavage followed by a large swallow of barium: A at the end of expiration, B at the end of inspiration. The indentation of the esophagus is produced by the rim of the esophageal hiatus.

by regurgitating the contents of the esophagus. He was never nauseated and could not vomit. Sometimes he would regurgitate unexpectedly and strangle. This occurred so frequently in his sleep that he was obliged to adopt a semirecumbent sleeping position. After a time he developed a technic of partially emptying the esophagus before going to bed. Lying on his side, with his head lowered, he would exhale as completely as possible, approximate his shoulders, and spasmodically contract his abdominal muscles. Like many other patients with esophageal obstruction he used a method to force the esophageal contents into the stomach. To do this he swallowed air, then took a deep breath, and attempted forced expiration with the mouth and glottis closed. In this maneuver he also approximated his shoulders and pressed his arms against the anterolateral walls of the chest.

It was over a year after the onset of his illness before the patient consulted a physician. He was told that he had cardiospasm and was unsuccessfully treated. The exact record of treatment was not obtained but apparently bougies were passed down the esophagus without producing relief. In view of the findings it is doubtful that the bougies passed through the entire esophagus.

The patient was fairly well nourished and well developed, mentally alert and of a pleasant personality. He did not show signs of weight loss, although he stated he had lost about 20 pounds in the past two years.

Blood and urine examinations were reported normal.

X-ray examination, Nov. 10, 1937, showed a large esophagus containing a considerable quantity of food residue (Fig. 1). The dilated portion of the esophagus extended through and about 12 cm. below the diaphragmatic hiatus. The dependent portion ended in a rounded, pouch-like dilatation (Fig. 2). At intervals deep contractions occurred which moved downward only a few centimeters and then relaxed. Sometimes two or three contrac-

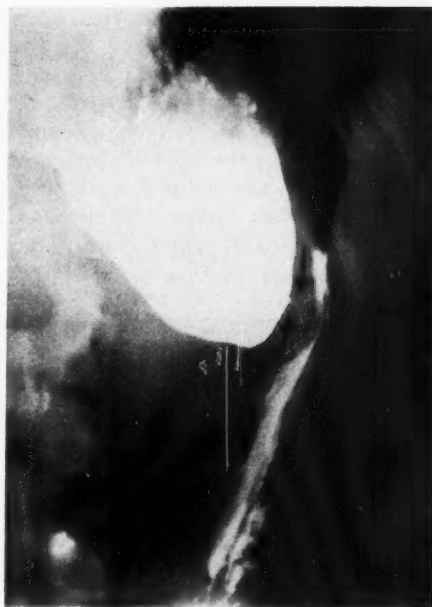


Fig. 3. Narrowed segment of the distal 2 cm. of the esophagus, indicated by arrows. A small amount of barium is present in the stomach and a gas bubble is present in the fundus.

tions would be visible at different levels, varying in depth, giving to the esophagus a writhing, twisting movement. No barium was seen to pass out of the distal end until the patient forced some through by the maneuver above described (Fig. 3). A small stream of barium passed out of the left border about 6 cm. proximal to the most dependent portion, revealing a narrowed segment of esophagus, about 2 cm. in length, connecting with the stomach. The entire esophagus proximal to the narrowed segment was dilated and had an average diameter of 8 cm. Re-examination at a later date, Nov. 30, 1937, after a thorough lavage, showed essentially the same findings. Preceding this later examination films of the chest were taken to show how the patient could produce a pneumoesophagus of his own volition (Fig. 4).

Treatment at first was by lavage and attempted passage of a bougie. A large amount of thread was swallowed but it did not pass into the stomach. Atropine

was given until there was a marked physiological effect without evidence of relaxation of the cardia.

Esophagoscopy showed a hyperemia of the mucosal lining and a large amount of mucus clinging to the wall. The opening into the narrowed segment was not seen.

The patient was operated upon, Dec. 9, 1937, by Dr. Allen O. Whipple, who opened the peritoneal cavity through a left para-

and to the right side of the cardia, leaving the cardia to the upper and left-hand side of the blind pouch of the esophagus. The cardia could be easily felt as a contracted, firm, oval structure, resembling closely the pyloric hypertrophy seen in infants. It lay about 2 or 3 cm. below the diaphragmatic opening. A finger could not be passed through it and there were some large vessels running up toward the cardia.

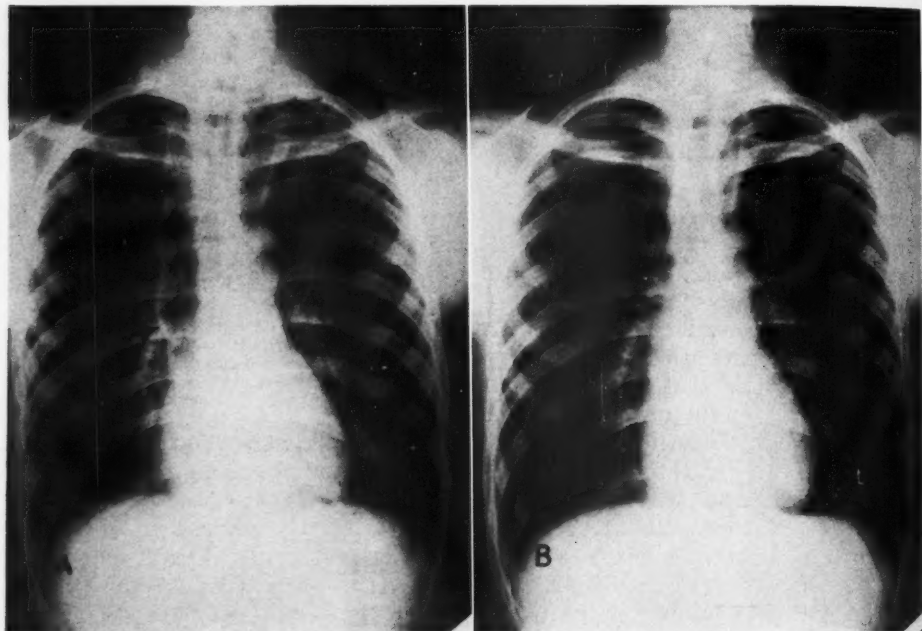


Fig. 4. Chest films, posterior-anterior view, showing (A) pneumoesophagus produced voluntarily by the patient. The arrows point to the margin of the esophagus. B, when the patient has not produced a pneumoesophagus, is for comparison with A.

costal incision. The following description is quoted from his operative notes: "The findings in this case presented a most remarkable picture. Evidently due to a long period of cardiospasm, which the patient had tried to overcome by swallowing large amounts of air and pushing against his diaphragm in order to get fluid into his stomach, the esophagus had become markedly hypertrophied. The diaphragmatic opening of the esophagus had become greatly stretched, resulting in the prolapse of the lower 10 or 12 cm. of the esophagus. This had rolled down

This, together with the realization that, if a cardioplasty were done, the scar would contract with the continuation of the psychogenic factor, made it evident to the operator that an anastomosis between the lowermost part of the esophageal pouch and the anterior wall of the stomach was the preferable procedure. There was no evidence of ulceration or any other pathology except a prolapse of the esophagus and the tremendous hypertrophy of its walls."

The dependent portion of the esophagus was anastomosed with the anterior wall of the pars media of the stomach near its

lesser curvature. The patient had an uneventful convalescence. On the seventh post-operative day he began eating semi-solid foods without any discomfort and with no apparent delay in passage through the anastomosis.

The patient was re-examined roentgenographically by Dr. Haig Kasabach in April and again in June, 1938 (Fig. 5). These examinations showed no delay in the pas-



Fig. 5. Esophagus six months after esophagogastrostomy. Comparison with Fig. 2 shows the reduction in size and also retraction of the stoma above the level of the hiatus.

sage of the barium column when the patient was standing erect. The esophagus was considerably smaller than on the first examination. Its total length had decreased and the stoma was near the level of the hiatus. The patient had gained weight and said he ate anything he cared to without difficulty.

SUMMARY

The diagnosis, etiology, and treatment of cardiospasm are briefly discussed. An unusual complication of cardiospasm, herniation of the esophagus through the hiatus into the abdominal cavity, is reported.

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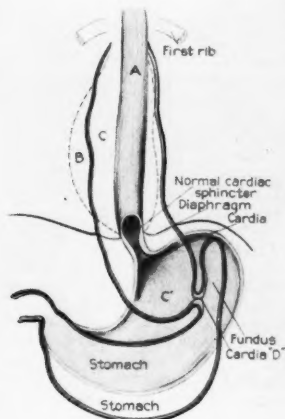


Fig. 6. A diagrammatic drawing of the normal esophagus (the heavy shading), the usual appearance of the esophagus in cardiospasm (the broken line), and the case herein reported (the heavy lines).

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LOW-VOLTAGE CONTACT ROENTGEN THERAPY (CHAOWL THERAPY)¹

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IN 1931, proceeding on the assumption that it has never been demonstrated that the biological effect of radiation is dependent upon its wave length and that there is, on the contrary, a considerable weight of evidence against such a thesis, Chaoul and Adam began to investigate the possibility of using low-voltage radiation applied under conditions approximating

represented by a half value layer of 0.37 mm. Al, with the results of irradiation of the skin with gamma rays. With equal amounts of energy he found no qualitative or quantitative difference in erythema or epilation, and in another series of experiments he noted no difference in the effects on *Ascaris* eggs. Englemann has shown that with like amounts of radiation,

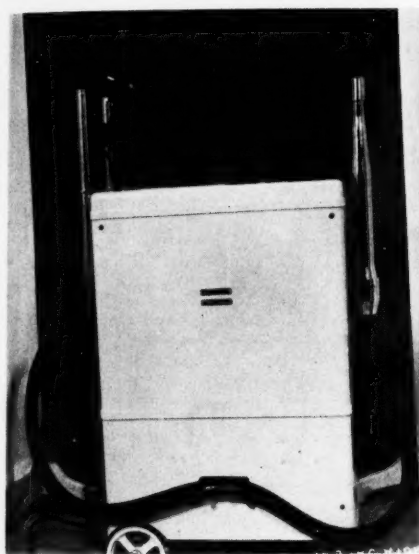


Fig. 1. Contact therapy unit.

those obtaining in the surface application of radium. Their motivation was, of course, the scarcity and high price of radium in Germany. Briefly stated, their thesis was this: It may be regarded as axiomatic that the effect of radiant energy depends, not on wave length, but on the total energy absorbed per cubic centimeter of tissue, and the time spacing or fractionation of that total energy.

Holthusen has compared the results of irradiation of the skin with rays of a quality

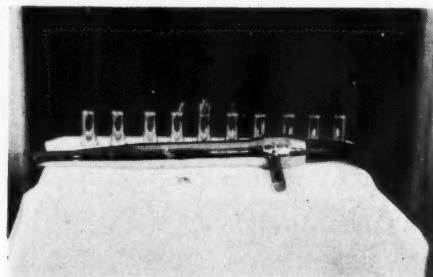


Fig. 2. Tube, localizing cylinders, and filters.

the morphological changes observed in tumor cells were identical whether low-voltage x-rays or gamma rays were employed.

The conditions which obtain in radium therapy (except teleradium therapy), and which it was sought to approximate, are; (1) a short distance between the surface and the source of radiation, (2) a consequent absorption of a large amount of the energy in the first few centimeters of tissue.

To fulfill these conditions it was necessary to devise a special apparatus which was shock-proof, which had a very low inherent filter value, and which was so constructed that the anode-surface distance was very short. Furthermore, the radiation produced should be relatively soft, and the fields irradiated should be small. All of these conditions are met in the apparatus which we have employed, namely, the Philips Metalix Contact Therapy Unit (Fig. 1), operating at 50 kv.

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TABLE I.—PERCENTAGE DEPTH DOSE (H₂O)

Voltage 50 kv. (constant potential). Current 2 ma. Field 2.5 cm.

Distance	Filter	Depth Dose			
		0.0 cm.	1.0 cm.	2.0 cm.	3.0 cm.
2.0 cm.	0.0	100%	22%	7.8%	3.5%
2.2 cm.	1.0 mm. Al	100%	33%	13.5%	6.5%
2.2 cm.	2.5 mm. Al	100%	37%	17.5%	8.4%
4.0 cm.	0.0	100%	30%	13%	6.9%
4.2 cm.	1.0 mm. Al	100%	45%	25%	13.5%
4.2 cm.	2.5 mm. Al	100%	51%	30%	18.0%

TABLE II.—INTENSITY OF RADIATION

Voltage 50 kv. (constant potential). Current 2 ma. Field 2.5 cm.

Distance	Filter	Intensity in Air	Back-scatter	Half Value Layer
2.0 cm.	0.0	7400 2/min.	6.0%	0.2 mm. Al
2.2 cm.	1.0 mm. Al	1278	9.0%	1.0 mm. Al
2.2 cm.	2.5 mm. Al	506	10.5%	1.4 mm. Al
4.0 cm.	0.0	1850	6.5%	0.2 mm. Al
4.2 cm.	1.0 mm. Al	350	10.0%	1.0 mm. Al
4.2 cm.	2.5 mm. Al	139	12.0%	1.4 mm. Al

constant potential, with 2 ma. of current passing through the tube.

The tube used is constructed with a metal sheath, is ray-proof, shock-proof, and has a high-tension connection only to the anode, the cathode side being grounded. It is cooled by an air blower. It is cylindrical in shape and measures 23.7 inches in length, with a diameter at its distal end of 1.18 inches. It is, therefore, easily introduced into body cavities and into surgical incisions. The radiation emerges axially, passing through a glass window and a protective cap of a plastic material having a total inherent filter value of 0.2 mm. Al. The anode-surface distance is 18 mm. The tube is usually used with a rubber covering, which adds 2 mm. to the distance, and if filters are employed the total anode-surface distance becomes 22 mm. From this extremely short anode-surface distance there result an extraordinarily high r-per-minute afflux and a spatial distribution of the radiation closely resembling that of radium. Because of the low voltage employed, the radiation is of long wave length, the quality being represented by a half value layer in aluminum of 0.2 mm. if no added filter is employed, and 1.0 mm.

if 1.0 mm. Al is added. Additional filtration does not result in marked hardening, 2.5 mm. Al added producing a half value layer in aluminum of 1.4 mm. With this filtration the beam becomes practically homogeneous and cannot be further hardened.

The technical factors regularly employed are 50 kv. constant potential, and 2 ma. current. The radiation may be filtered by 1.0 or 2.5 mm. aluminum and the anode-surface distance may be varied somewhat. The distance with no filter is 18 mm. and the radiation intensity is 7,420 r per minute. With a filter of 1 mm. Al, the anode-surface distance increases to 20 mm. and the r afflux becomes 1,278 r per minute. Note that the filter thickness is 2 mm.; it is the equivalent value in aluminum that is expressed as 1 mm. With 2.5 mm. Al the r output decreases to 506 r per minute. Localizing cylinders (Fig. 2) are supplied, and one of these has a metal cuff which serves to increase the anode-surface distance to 42 mm. At this distance the r afflux becomes 350 r per minute with an equivalent filtration value of 1.0 mm. Al and 139 r per minute with 2.5 mm. Al. These localizing cylinders are placed



Figs. 3-5. Use of localizing cone in treatment of superficial skin lesions (Fig. 3); tube supported by tube stand (Fig. 4); localization of intra-oral lesion by localizing cylinder (Fig. 5).

over the area to be treated (Fig. 3)—one being chosen of such size that the lesion fits within the opening—and the tube is introduced into the cylinder. These cylinders may be sterilized and introduced into body cavities and through surgical wounds. The tube may be used in its support on the unit (Fig. 4) or it may be held with impunity in the operator's hand. Greater distances than 42 mm. may be employed, of course, after the r at the surface have been measured. In fields above 5 cm. in diameter, however, the distribution of the radiation becomes very uneven at the edges of the fields and these must be marked off rather carefully.

It may be stated as axiomatic that successful radiation therapy contemplates a maximum of damage to the tumor cells and a minimum injury to the surrounding normal structures. The combination of soft radiation and an extremely short anode-surface distance which obtains in contact therapy permits close approximation to this ideal, since in general the tumor tissue is in contact with the source of radiation while the adjacent tissues are protected by the laws of geometry. A glance at the depth dose tables (Table I) and the figures for back-scatter (Table II) will make clear this point. With no added filter and with a total anode-surface distance of 20 mm., the depth dose at 2 cm. is only 7.8 per cent, and the back-scatter at

the surface is 6 per cent. With 2.5 mm. Al added filter (the heaviest filter employed) and at an anode-surface distance of 42 mm. (generally speaking, the maximum distance), the depth dose at 2 cm. is 30 per cent and the back-scatter at the surface is 12 per cent. Safeguarded by these factors, unusually large total doses of radiation may be given with impunity.

Chaoul, den Hoed, Schaefer, and others have described contact therapy with daily doses of from 300 to 500 r, and total doses of 8,000 to 10,000 r, employing fields of 8 sq. cm. or less. Under these conditions the skin reaction is not very marked, consisting of erythema and occasionally slight vesiculation. We have found that considerably greater amounts of radiation than these may be given safely to small fields measuring up to 7 sq. cm. in area, and in some instances we have given as much as 30,000 r to a single area of approximately 6 sq. cm. in fractions of 2,500 r given on alternate days. The resulting reaction varies considerably with the type of tissue irradiated. The buccal surface of the cheek, for example, will show a violent reaction, accompanied by a grayish yellow membrane, sloughing, which is very superficial, and rather marked pain. The bladder mucosa, on the other hand, exhibits a trifling reaction consisting only of redness. These reactions will be discussed in detail later. Van der Platte and

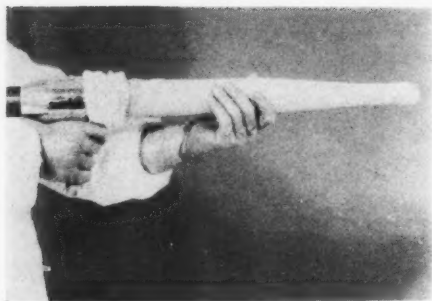


Fig. 6. Tube dressed surgically for use in body cavity.

den Hoed have administered cancericidal doses (which they consider to be 4,000 to 5,000 r) to small epitheliomata in a single treatment, a matter of some practical importance when a patient lives at a distance and cannot return periodically.

In general it may be said that the reactions appear somewhat earlier than with conventional therapy; that they are less painful than the usual reactions; and that an exudative epidermitis characterizes the reactions following the larger total doses. Changes in the tumor are commonly noted before the end of the treatment series. The total dose must be determined by the behavior of the tumor rather than by a fixed plan of treatment, but in any event one should endeavor to administer 3,000 to 4,000 r to the tumor base. The cosmetic results are very satisfactory.

The ease of application, the short treatment time, and the comparative mildness of the reaction make contact therapy the method of choice in the treatment of lesions often previously treated with surface radium application. It will not replace interstitial radium therapy, nor should it be substituted for radium in the treatment of the more deeply situated tumors. In such conditions the very factors which permit intense irradiation of accessible lesions conspire to prevent effective treatment at a depth of even 2 or 3 centimeters. A regional lymph node, for example, had best be treated by higher-voltage radiation, permitting a greatly improved depth dose, since the superficial caustic effect of con-

tact therapy is too great as compared with its efficiency at such a depth.

CASES SUITABLE FOR TREATMENT

For the rather common skin epitheliomata contact therapy is an ideal method of treatment, since it is simple in application and since the spatial distribution of the energy affords excellent protection to the underlying normal tissues. The treatment is easily localized, and complete protection to adjacent structures, *e.g.*, the eye, is afforded. We have employed total doses of from 5,000 to 10,000 r (with a half value layer in aluminum ranging between 0.4 mm. and 1 mm.) to the surface, depending upon the thickness of the lesion treated. The results have been excellent and there has been a minimum of scarring.

We have been greatly encouraged in the treatment of lip cancer by this method. The simplicity and ease of application contrast markedly with the cumbersome radium mold applicators and the disagreeable needle implantation. If there is regional lymph node involvement the nodes must be dealt with otherwise, but for the lip lesion the method seems ideal. We have employed doses of from 7,000 to 9,000 r with a half value layer in aluminum of 1 mm., using a field just larger than the growth. Considerable swelling and exudation follow such amounts of radiation, with crusting as the final stage of the reaction. Both the clinical and the cosmetic results have been excellent.

The oral cavity is, of course, easily accessible, and the construction of the contact therapy tube permits its introduction into the mouth for the treatment of intra-oral lesions. The use of intra-oral cones is not a new procedure, but with high-voltage radiation one encounters several difficulties. The prolonged treatment time is annoying to the patient; it is difficult to localize the lesion and to maintain its relationship to the cone; and the skin of the cheek or neck receives almost as much radiation as does the tumor. With contact therapy one may easily localize the area to be treated (Fig. 5); the treatment time will seldom

be more than one minute; and even when the growth is located on the buccal surface of the cheek, the skin will not receive more than 40 per cent of the tumor dose. The exact localization which is possible effectively prevents the painful mucosal reaction and mouth dryness which so regularly follow high-voltage external radiation.

Ulcerating carcinomatous masses, as may be seen in advanced breast cancer, or in cancer of the genitalia, may be very satisfactorily treated. In such instances the treatment is not relied on to reduce the tumor mass greatly, but only to heal the ulcerating area. To relieve the patient of a foul discharging lesion, even though the ultimate course is but little influenced, is a distinct service. To such areas very large doses may be given, as high as 30,000 r to a single field, since the effect is quite superficial and since only cancer tissue is undergoing destruction. In one case of a bladder cancer fungating through an abdominal scar we gave 31,000 r to each of three areas over the tumor, avoiding the skin but overlapping the fields indifferently. No severe reaction followed; the mass disappeared.

Contact therapy has been employed for irradiation of the parametrium in cancer of the cervix, introducing the tube into the vagina and irradiating through each lateral fornix. For reasons already given we do not believe this to be a logical procedure, and we do not employ it. We have found contact therapy useful, however, to control large necrotic bleeding cervical carcinomata, and have observed prompt cessation of hemorrhage and notable decrease in the bulk of the tumor treated. When we use this method thus, we proceed with our high-voltage x-radiation and radium treatment as though no other treatment had been given. In brief, we consider contact therapy in carcinoma of the cervix to be useful solely as an adjuvant.

Numerous uses for contact therapy suggest themselves and need not be dwelt upon here. Warts respond readily; favorable results have been reported in the treatment of keloids, hemangiomas, and numerous skin lesions. In the treatment

of the latter it is advisable to increase the anode-skin distance to 5 or 10 cm. in order to decrease the intensity of the radiation and increase the size of the field.

An entirely new field of usefulness and apparently offering great promise is that of contact therapy of surgically accessible lesions. Elsewhere we have reported the immediate results of the treatment of cancer of the bladder after surgical exposure by marsupialization. We have been very favorably impressed with the results in a small series of cases, the tumor having disappeared promptly in each instance. The total doses were large, being from 25,000 to 30,000 r in a single area. The reactions were amazingly mild, and each of the patients thus far treated has had an uneventful convalescence. Obviously not enough time has elapsed to permit any evaluation of the final results, but we feel that the method deserves a thorough trial. We have also irradiated metastatic carcinoma in abdominal lymph nodes during laparotomy, and have treated one spinal cord tumor at laminectomy. There is no reason why cancer of the cardiac end of the stomach could not be treated through a large gastrostomy, and many other possibilities will present themselves.

CONCLUSIONS

We have discussed a new method of irradiation therapy which seems highly desirable in a comparatively limited field.

The high roentgen intensity permits very short treatment periods.

The extremely short anode-surface distance invokes the inverse square law as a protection to underlying tissues, but at the same time limits the use of this therapy to superficial lesions or those which can be made superficial surgically.

The physical characteristics of the roentgen tube permit its sterilization (Fig. 6) and its easy introduction into both the naturally accessible body cavities and into those which can be made accessible by surgery. This latter field we consider one of great promise.

IRRADIATION OF BRAIN TUMORS AT BELLEVUE HOSPITAL 1924-1939¹

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CLINICAL tests, properly observed and cautiously interpreted, offer the best standard by which to study the effects of irradiation on brain tumors. Treatment of such tumors has been to a great extent surgical. Irradiation as hitherto employed has not, except in a few types, proved adequate to control the disease. Because of the prevalent impression that brain neoplasms are generally radioresistant little else but palliative therapy has been administered in these cases.

The aim of radiation therapy is so to treat the pathological brain tissue as to destroy it without destruction of the surrounding normal cells during the course of treatment. Because of the fear of damage to normal brain tissue, large doses of radiation have not been employed until quite recently. It has been our experience that such doses properly administered have not damaged the normal tissues, while the tumor growth succumbs to this heavy treatment.

Irradiation of intracranial tumors is a therapeutic measure of established value, and even slow-growing tumors may be effectively irradiated. In the treatment of gliomas irradiation offers definitely effective results. Notwithstanding the controversies as to its value in the treatment of brain tumors, we believe that the remarkable results achieved through irradiation abundantly warrant reliance upon it. The procedure calls for the expert use of surgery, x-rays, and radium.

As a rule, irradiation is carried out with high-voltage x-rays or the radium pack. Not all types of tumors respond to irradiation,

but with the newer methods of treatment, entailing the administration of doses much greater than those hitherto employed, neoplasms formerly considered resistant have been placed in the responsive class. Davidoff and his co-workers have reported the application of large single doses of x-rays to surgically exposed brain or spinal cord. Direct irradiation is described also by Carty and associates. With this method, using x-rays activated at 60 kv., and giving 2,000 r in twenty minutes, definite tumor cell destruction has been noted. The employment of such low voltages obviously necessitates surgical exposure. Direct irradiation within the skull has not as yet, however, demonstrated in a great number of cases any superiority over therapy administered through the normal surface tissues. Interstitial radium therapy may be reserved for the more radioresistant tumors. In this type of treatment adequately filtered radium applicators containing small amounts of radium are inserted into the tumor for a given length of time, thus administering the dose over a long period, rather than employing a large initial dose for a shorter time.

When properly directed, irradiation through the intact skull provides efficient protection for radiosensitive tissues. Experience seems to show that the results depend in great measure upon clinical judgment. Some cases call for surgery with irradiation; in others, irradiation alone will produce the desired effect. Irradiation, whether by x-ray or radium, is given slowly in order to avoid undue reactions. Superficial tumors may receive moderate doses through a single portal; deeply situated tumors must be treated more actively through multiple ports.

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The present report is based upon a series of 154 brain tumors treated by irradiation at Bellevue Hospital. Excluding pituitary tumors, there was a total of 115 cases, of which 10 were of the cerebellum. Unfortunately, definite histologic reports were not always available, and a number of these cases were designated simply as "brain tumors." Fourteen were definitely classified as gliomas. The medulloblastomas were the most sensitive, and in these irradiation proved quite effective. The spongioblastoma multiforme was somewhat sensitive to irradiation; the astrocytomas and ependymomas but slightly so. The oligodendrogliomas seemed to be radio-insensitive. Because irradiation tends to create a hyperemia and some edema, it was deemed best, when possible, to irradiate only following surgical exploration and decompression.

Considerable caution must be exercised when giving x-ray treatments to a brain neoplasm. Often at the beginning of treatment headaches are redoubled in intensity, vomiting becomes more frequent, and visual disturbances are more pronounced. Occasionally there is danger of coma or even of death.

As for the method of treatment, we believe that in every case of suspected brain tumor operation should be done in order to ascertain definitely that one is dealing with a neoplasm and not with some other condition. Moreover, surgical exposure makes it possible to localize the new growth properly and to define its character, so that no time need be lost in irradiation should the tumor be recognized as of a resistant type.

For *x-ray therapy*, we usually employ 200 kv., with a filter of 0.5 mm. copper plus 1.0 mm. aluminum, at a distance of 40 or 50 cm., with 4 to 8 portals depending upon the site and the size of the lesion and of the skull. Treatment is given daily, the dose varying from 100 to 300 r per treatment delivered to one or more portals, depending upon the type of lesion. The total dose to each area varies from 1,000

to 1,500 r in each series. Several series may be given. In some cases a total dose of 42,000 r was administered over a period of months. In this manner it is possible to administer very large doses which will affect gliomas more favorably than the smaller usual doses reported. In spite of the intensive therapy, normal brain tissue in our cases was apparently not adversely affected. The following case is illustrative.

Case 1: A. G., age thirty-three, was first seen in the Radiation Therapy Department on Nov. 26, 1935. He had been treated for syphilis from time to time since 1921. His present illness began in 1932 with an epileptic attack. A second seizure occurred four months later, after which attacks continued with increasing frequency. They were reduced somewhat following antisyphilitic treatment. The patient was over-talkative and inaptly jocose. His left pupil was slightly irregular and larger than the right. There was slight bitemporal pallor. Blood and spinal Wassermann tests were negative.

Encephalography revealed a lack of filling of the anterior portion of the right lateral ventricle. In the anteroposterior view the left lateral ventricle was also tilted upward. It was believed that this might be due to a mass located in this area, blocking the right foramen of Monro.

At operation, Oct. 30, 1935, a right fronto-temporal osteoplastic flap was reflected. Deep in the substance of the right frontal lobe and near the ventricle a soft glistening substance was seen protruding. The tissue was thought to be gliomatous. A biopsy specimen was taken and a subtemporal decompression done. Histologic examination revealed no definite pathology. Following operation the epileptic seizures recurred and were accompanied by headaches.

From Nov. 27, 1935, to Jan. 9, 1936, the patient received 1,500 r high-voltage x-ray therapy to each of six portals for a total dose of 9,000 r. Epileptic seizures abated until May, 1936, when they recurred

daily. From May 5 to June 17 an additional course of 9,000 r was given. The headaches improved somewhat, and a third course of 9,000 r was administered, Aug 10 to Oct. 1. By Nov. 24 the attacks had diminished further, occurring only once every six weeks. From Nov. 25, 1936, to Jan. 20, 1937, the patient received another course of 9,000 r. By June, 1937, his headaches had improved further, occurring only in damp weather. He had had but one severe attack and six mild attacks in the past month. Between July 26 and Sept. 3 he received an additional 6,000 r. The attacks continued to diminish gradually and when the patient was last seen in April, 1939, he had had only six mild momentary stumbling spells in the past two months. He felt very well otherwise. There was slight left facial weakness with retraction of the head slightly to the right.

Summary: A case of glioma of the brain is recorded from which a biopsy was taken at operation in 1935 but proved unsatisfactory. The progress of the disease was arrested for four years. A total dose of 42,000 r (in air) was delivered over a period of two years to the skin, but in spite of this intensive therapy the patient's hair again grew in. The total depth dose was 25,200 r (with back-scatter).

For *radium therapy*, the 5-gram radium pack is employed, delivering 5,000 milligram hours of radium at 6 cm. distance, filtered through 2 mm. platinum, each hour it is applied. From 4 to 8 portals may be used, each receiving a dose of 10,000 to 50,000 milligram hours over a period of several days or weeks. If several areas are to be treated in a single session, the pack is applied to each area for one-half hour, delivering 2,500 milligram hours to each area. If but one or two areas are treated per session, application is for an hour per area, giving 5,000 milligram hours. The number of applications depends upon the dose given at each session and the total dose to be administered. In most instances patients have well tolerated

radium pack treatment for one to four hours at a time, with no untoward effects. The radium pack treatment offers the advantage of effective intensive gamma irradiation through the surface of the skull with little accompanying discomfort.

Gold-filtered radon seeds have been employed for interstitial therapy in conjunction with surgery. In our opinion this method offers no advantages over surface irradiation with the pack.

PITUITARY TUMORS

The series under consideration included 45 pituitary tumors, or more than 25 per cent of all brain tumor cases referred to the Radiation Therapy Department at Bellevue Hospital. Since Bécélère's first memorable work on the treatment of these tumors by x-ray therapy, great advances have been made, and continued study and experience have failed to evolve a more scientific rationale for the therapy of pituitary neoplasms.

Henderson recently reviewed the results of a large series of cases treated surgically by Cushing. While an appreciable number were improved by surgical procedures, even better results were achieved in a number of instances where irradiation was employed. From the results of ten years' observation, as reported by Huet, it may also be concluded that irradiation is of definite value in pituitary disorders.

Three groups of pituitary tumors are recognized: the chromophobe adenomas, the acidophil adenomas, and the basophil adenomas. Of these the basophil adenomas are most radioresponsive. The effect of irradiation is achieved through direct control of hyperplastic and hyperfunctioning cells.

For the chromophobe adenomas, surgery is the method of choice. These tumors act mechanically in producing symptoms. Endocrine disturbances are not noted; the sella is usually distended; and compression of the optic nerve results in visual disturbances. Surgical removal of the tumor is required for relief, though

x-ray therapy may be attempted for possible reduction of the bulk of the growth.

The chief symptoms of the acidophil adenomas are headache and endocrine disturbances. This type of tumor is moderately radiosensitive, and irradiation is the method of choice. As Sosman states, acidophil adenomas are more responsive to irradiation than the chromophobe type. Acidophil adenoma accompanied by acromegaly is a variable disease. Some of these neoplasms grow rapidly and progressively, causing an early exitus. In others, more slowly growing, we have seen definite halting of the acromegalic tendency and relief of symptoms following treatment. Rapid terminal proliferation may occasionally occur after several years of apparent spontaneous arrest of the growth. It is our policy, therefore, to administer irradiation on the assumption that the tumor is actively growing even though the symptoms may have been static for several years. In several instances in which the symptoms had been quiescent for three to four years, small doses of radiation were given, only to be followed sometime later by progressive growth and fatal termination. It is our custom now even in such mild cases to instigate intensive therapy so as to inhibit later adenomatous growth.

In the several cases of acidophil adenoma of the pituitary gland in which bio-assays of estrin and prolactin in the blood and urine were performed, estrin was found to be normal in amount and prolactin low or absent. This does not necessarily signify diminished prolactin production, since prolactin may normally be absent from the blood or urine. The point we wish to make here is that prolactin production was not excessive in the presence of acidophil adenoma.

The benign functionally hyperplastic pituitary gland frequently produces symptoms that may suggest a true neoplasm. These are attributable to the basophil cells which produce prolactin and which become hyperfunctioning and occasionally hyperplastic when the ovarian secretions are diminished or absent, as at the meno-

pause, following radiation or surgical castration, or, occasionally, with ovarian failure in young women. The pituitary in this condition may be normal in size and be associated with symptoms of the menarche, or it may enlarge within the confining sella turcica and produce headache, migraine, and vertigo. From the radiotherapeutic point of view this hyperfunctioning endocrine gland, which is normally rather radioresistant, becomes radiosensitive. A similar phenomenon is observed in Graves' disease, when the normally radioresistant thyroid gland becomes radiosensitive. This is probably true also of the ovary (estrogen-producing granulosa-cell tumor) and the adrenal gland (pseudohermaphroditism associated with adrenal cortex hyperplasia).

At the menopause it is often difficult and occasionally impossible to differentiate between a true adenoma of the pituitary gland and secondary pituitary hyperplasia, as prolactin assays may reveal a slight increase in the production of prolactin in either instance.

The hyperfunctioning gonadotropic cells of the pituitary gland, which may or may not be associated with a slight swelling of the gland, are radiosensitive. In the presence of severe menopausal symptoms, such as frequent hot flashes, severe headache, vertigo, migraine, etc., regardless of their origin, hyperfunction may be diminished by moderate doses of x-ray therapy. A total dose in the pituitary of 1,200 to 1,800 r (measured with backscattering) is sufficient.

In none of our cases where there was an enlarged sella turcica, demonstrated roentgenographically, was there any evidence of shrinkage or increased sclerosis of the walls of the sella following arrest of the symptoms. There was no shrinkage of any of the enlarged bones, though in some cases there was a diminution of the soft tissue swelling of the lips and other parts of the face so that the features became somewhat less coarse. Even this was difficult to measure accurately. As already stated, there was no evidence of

damage to the brain or to the normal pituitary gland. As a matter of fact, in one instance (Case 2), where an acidophil adenoma had produced amenorrhea, which we assumed to be due to inactivation of the basophilic cells of the pituitary gland as a result of pressure by the tumor, the relief of symptoms following radiation therapy was attended by a return of the menses. It might be assumed that the basophilic cells were compressed by the tumor and were thus rendered resistant to irradiation, and that following the shrinkage of the tumor, the cells enlarged and resumed function. No permanent epilation was produced in any of our cases.

There is considerable variation in the dose required for pituitary lesions. Many cases reported in the literature were treated with doses which we would now consider to be insufficient. With courses of protracted fractionated irradiation, enormous total dosages, as high as 42,000 r (measured in air), may be delivered to the scalp without any later evidence of damage to the brain or to the normal portion of the pituitary gland. As mentioned above, there is apparently a wide difference between the radiosensitivity of normal and proliferating pituitary cells.

Our technic of irradiation entails the following factors: 200 kv., 20 ma., 50 cm. distance, 0.5 mm. copper and 1.0 mm. aluminum filter, portals 4×6 and 6×8 cm. Treatment is delivered through 6 ports: right and left frontal (4×6 cm.), right and left temple, bregma, and vertex. A daily dose comprises 150 r (measured in air) to each of two portals. Treatments are given five or six times a week until a total dose of 1,500 r over each portal is administered. The average course of therapy entails a total dose of 9,000 r (measured in air) delivered to the scalp. The average depth dose, in the pituitary gland, is 50 per cent of the surface dose. Consequently within a period of about two months, or somewhat less, with such a course of radiation the pituitary should receive some 4,500 r (with back-scatter). A second course may be given in two

months and repeated at intervals of five to seven months. In one case, we administered three such courses, giving a total tumor dose of 18,000 r (with back-scatter) to the pituitary gland over a period of fifteen months. Another patient was given the same total dose in three courses with an interval of three years between the second and third courses. In none of our cases was there any permanent epilation or damage to the cornea or lens.

Case 2: In 1928, E. H., age forty, noticed a rapid enlargement of the bones of the face, head, hands, and feet, so that she required larger hats, gloves, and shoes. The rapidity of the growth was marked for about four months, following which it became stationary. In addition there was a constant dull ache over the left parietal region, unaccompanied by any weakness and relieved by large doses of aspirin. There also appeared a gradual but marked blurring of vision. There were occasional triplopia and diplopia.

When examined on July 23, 1931, three years after onset, the patient showed a typical acromegalic appearance. She weighed 148 pounds, having lost 14 pounds. X-ray examination revealed a markedly enlarged sella turcica. There was restriction of both upper visual fields, greater on the left. There was also a central scotoma on the left.

X-ray therapy was given as follows:

July 23-Aug. 26, 1931. . . . 5×600 r = 3,000 r

Nov. 9, 1931-Jan. 26, 1932. . . . 5×600 r = 3,000 r

March 30-April 22, 1932. . . 2×600 r = 1,200 r

July 25-Sept. 2, 1932. . . 3×600 r = 1,800 r

At the first examination there was noticed a large non-toxic goiter and 750 r were directed to the thyroid area. After this course of treatment, the patient felt better, the headache disappeared completely, and she could see more clearly except at night when she lay down, when

slight pain was present over the left eye. The hands and feet had shrunk so that gloves and shoes could be reduced half a size.

From Dec. 27, 1932, to March 27, 1933, 4×750 r (3,000 r) were given to the skull. At the same time, the thyroid gland received $2 \times 1,350$ r (2,700 r). Between June 8 and June 27 additional x-ray therapy was given to the thyroid: $2 \times 1,200$ r (2,400 r).

In November, 1935, menstruation was re-established, with regular monthly periods of four to six days. The patient continued to menstruate until February, 1939, at which time she entered the menopause at the age of forty-eight, having severe hot flushes. Whereas the menstrual function, the visual fields, and the headaches had shown improvement after irradiation therapy, there was no change in the sugar metabolism, the fasting blood sugar being 150.

The headaches recurred somewhat, so that, in spite of epilation over the temples, further treatment was given. From March 30 to May 1, 1936, the patient received $4 \times 1,500$ r (6,000 r) to the skull and at the same time $2 \times 1,350$ r (2,700 r) to the thyroid. At this time it was noted that the features were much less coarse, the nose finer and less bulbous, the lips smaller, and the zygoma not as prominent.

As a result of treatment the thyroid adenoma slowly and gradually softened and finally disappeared in January, 1938.

In 1936, multiple subcutaneous fatty nodules appeared, particularly along the extremities. A biopsy revealed adipose tissue. In addition, there was extensive pigmentation of the skin over the axilla and inguinal areas and to a less degree over the parts of the body occupied by the apocrine glands.

Summary: A case of progressively developing acromegaly has been recorded, in all probability due to an acidophil adenoma of the pituitary gland. In addition to producing local symptoms such as enlargement of the sella turcica and pres-

sure on the optic nerve, the adenoma apparently interfered with the function of the basophil cells so that amenorrhea resulted. Bio-assays of several specimens of urine revealed no prolactin. Over a period of five years a total dosage of 18,000 r (in air) was delivered to the skull. The dose in the pituitary gland was 10,800 r (with back-scatter). This produced temporary epilation at various times with a complete healthy regrowth of hair. The patient also had a non-toxic adenoma of the thyroid gland. This ordinarily radio-resistant tumor disappeared completely with a total dose of 8,500 r delivered over a period of several years, radiation being given at the same time as to the pituitary gland. Subsequently generalized subcutaneous lipoid nodules and marked pigmentation of the skin in the regions of the apocrine glands appeared, but whether or not these were part of the general syndrome cannot be clearly stated. It is possible that the pressure of the acidophil adenoma on the basophilic cells rendered them temporarily refractory to radiation so that after the adenoma had been destroyed and the pressure on the basophil cells released, the latter were able to resume function, with restoration of the menstrual cycle. This is a particularly hypothetical explanation for the return of the menses in spite of intense irradiation of the pituitary gland, over 10,000 r (with back-scatter).

CONCLUSIONS

Irradiation of intracranial tumors is a therapeutic measure of established value, and even slow-growing tumors may be effectively irradiated. In the treatment of gliomas irradiation offers definitely effective results. In our experience intensive dosages are necessary, and such treatment when properly administered is not destructive to normal brain tissue. We believe that when large doses of radiation are more generally employed, as here described, certain tumors hitherto considered radioresistant will be brought into the radio-curable class. For the treat-

ment of acidophil pituitary tumors irradiation is the method of choice and for functional pituitary hyperplasia it is an effective means of control. Treatment is carried out with high-voltage x-rays or the 5-gram radium pack.

Results depend in a great measure on clinical judgment. Treatment for brain tumors requires experience, skill, and caution in administration. In most instances irradiation should follow surgical exploration and decompression, but in some cases irradiation alone produces the desired results. Irradiation often relieves where the condition is not amenable to any other form of therapy.

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DISCUSSION

MERRILL C. SOSMAN, M.D. (Boston): Dr. Kaplan has covered such a wide field that it is impossible to discuss all of the points he raised. The shortest and most effective discussion I can give will be to summarize briefly the different types of tumors, the life expectancy in each, and their radiosensitivity.

As is well known, the acoustic neuroma is insensitive to x-rays and the length of life is of no value in determining the effects of treatment. This tumor will kill the patient by blocking the vital centers in the cerebellum.

The meningioma is best treated by surgery. It is not affected by x-ray therapy, and as far as our experience goes, it is not radiosensitive. The length of life is of no value in determining the effect of therapy. These tumors also kill the patient

because of their location and not by invasion. They usually push the brain out of the way.

The craniopharyngioma, the congenital tumor of children, is as far as we know radioresistant. Length of life is of no value in determining the efficacy of treatment. Though these are congenital tumors, they are sometimes found in patients of fifty years.

The gliomas, which constitute 42 per cent of all brain neoplasms, vary widely among themselves. The astrocytoma is a slowly growing tumor; it is frequently cystic and can be very well treated surgically and even cured, by which I mean that the patient may remain well ten years after the operation. Astrocytomas are insensitive to radiation. As to length of life, again one cannot say that a five-year cure proves the value of x-ray therapy.

The glioblastomas are moderately sensitive to radiation and length of life here is a definite indication of the value of x-ray therapy, since the average survival period is three years; more than this indicates a beneficial effect. Palliation, however, is all that is obtained; we have no cures.

The medulloblastomas are the most sensitive of all intracranial tumors. I rate these as three plus. In fact, we have advocated that if a tentative diagnosis of medulloblastoma can be made, it is best to treat with x-rays and not run the risk of spreading the tumor by operating. The average length of life for patients with these tumors is six months. A prolongation over two or three years proves the definite value of x-ray therapy.

As to the pituitary tumors, I agree with Dr. Kaplan that they are radiosensitive, say two plus as compared to the medulloblastomas. Length of life is no indication of the value of x-ray therapy because the pituitary tumors do not kill; they merely disable. The restoration of health and normal activity is the important thing, particularly restoration of sight.

The unclassified tumors vary all the way from insensitive to very sensitive. There is a great variety of such tumors,

as, for example, the angiomas, the pine-alomas, and the third ventricle tumors.

One word of warning I should like to give. Dr. Kaplan has mentioned a dose of 42,000 r, spread over a considerable length of time. Experiments have been made which convince me that if more than 6,000 r are given in any one series of consecutive treatments, there is an approach to brain damage; with over 6,000 r brain damage results, and with 10,000 to 12,000 r in one series the patient may be killed. I have seen this happen. In children the safe limit is 3,000 to 4,500 r in one series.

IRA I. KAPLAN, M.D. (*closing*): With regard to dosage, we have been limiting this in most instances to 6,000 r, but we have now risked 9,000 r. We now have 10 patients who were given this larger dose within a period of one month. Our judgment as to results in these cases is

not based on our opinion alone; the neurologist and the neurosurgeon must answer for the clinical symptoms. Their study of such cases has shown no damage to the brain.

Occasionally a tumor which has been previously classified as insensitive will respond to irradiation. We have one patient who was relieved of symptoms although the diagnosis was astrocytoma.

We do not feel that irradiation can now be considered equal to surgery as a therapeutic measure in brain tumors.

MERRILL C. SOSMAN, M.D.: May I make one correction? By 6,000 r, I mean 6,000 r in the brain itself. One may give 9,000 r to the surface and still be within the lower limit in the brain.

IRA I. KAPLAN, M.D.: We have not exceeded 6,000 r within the tumor.

PANCREATIC TUMORS¹

A ROENTGENOLOGIC STUDY

By SAMUEL BROWN, M.D., J. E. McCARTHY, M.D., and ARCHIE FINE, M.D.

AMONG the difficult diagnostic problems is that of pancreatic tumor, due principally to two factors: one, the anatomical position of the pancreas, lying as it does deep in the peritoneal cavity so that it is not readily accessible to palpation; the other, the superimposition of several organs in this region, each of which may be the site of a neoplasm, thus confusing the clinical picture.

The introduction of the roentgen ray in abdominal examinations has increased the accuracy of diagnosis of pancreatic tumors. Success, however, is due not to the direct visualization of the pancreas, as is the case with many other organs, but to indirect signs, revealed by changes in the position, shape, and contour of the stomach and duodenum as a result of pressure by the pancreatic tumor.

This indirect method of exploration of the pancreas is based upon certain anatomical relations existing between the stomach and duodenum and their contiguous organs, *viz.*: liver, spleen, kidneys, pancreas, gall bladder, common duct, jejunum, colon, lesser peritoneal sac, retroperitoneal lymph nodes, and abdominal aorta.

These considerations may be outlined as follows:

1. The stomach and duodenum occupy a definite place in the abdominal cavity and bear a constant relation to their neighboring organs.

2. The stomach and duodenum are relatively speaking freely movable structures. Their position, shape, and the distribution of their contents depend upon the position, shape, and size of the neighboring organs and the position of the body as a whole.

3. Changes in the contour, shape, and position of the stomach and duodenum exhibit certain characteristics depending upon the organ which is involved.

A knowledge of these distinguishing characteristics has enabled us to diagnose many abdominal neoplasms, which have been described in more or less detail in previous publications (1, 2, 3, 4, 5). In this paper consideration will be given principally to the diagnosis of pancreatic tumors. Several cases have been selected for illustration.

Case 1.—A sixty-three-year-old man, of hypersthenic habitus, complained of gastric disturbances. Roentgen examination of the stomach and duodenum in the prone position revealed absence of barium from the pylorus. Such a finding is usually due to pressure, but whence does this arise? Is it due to a lesion from within or without the stomach or to pressure of the body against the cassette? To ascertain the underlying cause the patient was placed in right lateral decubitus, which eliminated the factor of external pressure, so that there was complete filling of the pyloric end of the stomach. This roentgenogram also showed that the stomach and duodenum occupied a normal position in relation to the body as a whole and to each other. The duodenal loop which surrounds the head of the pancreas was not enlarged, indicating the probable non-existence of a pancreatic tumor. Operation for a gall bladder lesion revealed a normal stomach, duodenum, and pancreas.

Artificial deformity of the stomach and duodenum as a result of pressure may be eliminated by changing the position of the body or by lifting the abdomen from the cassette by means of pillows or other contrivances. The existence of pressure de-

¹ Presented before the Radiological Society of North America, at the Twenty-sixth Annual Meeting, Cleveland, Ohio, Dec. 2-6, 1940.



Fig. 1. Case 2: Anterior view. Pressure defect of pylorus due to an extrinsic cause.



Fig. 2. Case 2: Right lateral view. Pylorus displaced anteriorly due to pancreatic tumor.

fects in the stomach and duodenum is, however, often the first sign to draw attention to something abnormal within the abdomen and its etiology must be investigated.

Case 2.—A middle-aged woman presented symptoms suggestive of gall-bladder disease. Physical examination failed to reveal any palpable masses in the abdomen. Roentgen examination of the stomach in the anterior decubitus position showed absence of the barium mixture from the pyloric end of the stomach, evidently the result of pressure (Fig. 1). In the right lateral decubitus position the pyloric end was filled but displaced forward, while the descending portion of the duodenum remained in normal position, thus increasing the circumference of the duodenal loop (Fig. 2). An analysis of the two views suggests the following conclusion. The pressure defect in the pylorus may have been due in part to the pressure of the abdomen against the cassette. The fact, however, that there was an anterior displacement of the pylorus in the right lateral position would indicate the presence of some extrinsic mass within the duodenal loop. Since the head of the pancreas is bounded by the duodenal cir-

cumference, a tumor originating in the former would necessarily widen the loop and displace the pylorus anteriorly and upward. The diagnosis of a neoplasm in the head of the pancreas was confirmed by laparotomy.

Case 3.—A man, aged forty-six, complained of abdominal distress. Physical examination revealed a large mass in the epigastric region. X-ray examination of the stomach in the anterior decubitus position showed a large pressure defect in the pyloric region. The cardiac portion was displaced to the left and the duodenum to the right. In the right lateral position the stomach and duodenum were found to be displaced forward. It is of extreme significance that the descending portion of the duodenum was also displaced forward, which would indicate that the tumor must have arisen from structures posterior to it and not from those within, *i.e.*, the head of the pancreas. In addition the duodenal loop was actually diminished in circumference, thus excluding a pancreatic origin of the neoplasm. The diagnosis of a retroperitoneal tumor arising in the lymph nodes was suggested. This was confirmed by therapeutic test, for roentgen irradiation resulted in total regression of the tumor.



Fig. 3. Case 4: Anterior view. Stomach and duodenum normal in position, shape, and contour.

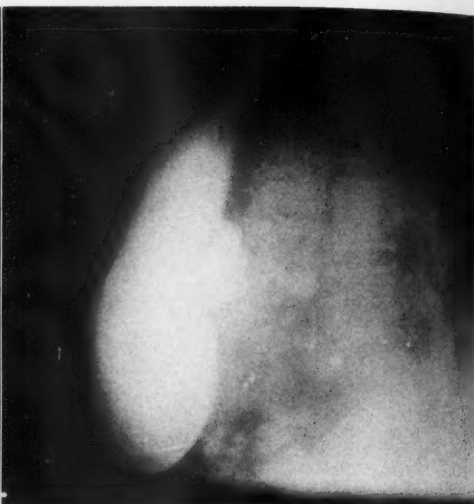


Fig. 4. Case 4: Right lateral view. Pylorus and duodenal bulb displaced anteriorly; descending duodenum deformed due to a pancreatic tumor.

Case 4.—A woman, fifty-six years old, complained of gastric disturbances. Physical examination was negative. X-ray studies in the anterior view showed no abnormal changes in the position, shape, or contour of the stomach or duodenum (Fig. 3). Fluoroscopically, gastric hyperperistalsis and a delay in the passage of the barium through the descending portion of the duodenum were observed. In the right lateral position the pylorus and duodenal bulb were found to be displaced forward. The descending duodenum presented a deformity in its contour which encroached upon the lumen, but its position was normal (Fig. 4). A tumor arising from the descending duodenum is quite rare and usually is too small to exert any pressure upon the neighboring organs. A tumor arising from the head of the pancreas, however, might displace the pylorus and at the same time invade the wall of the duodenum, producing an obstruction. The diagnosis of a cancer of the pancreas was confirmed by operation.

Case 5.—A man, aged sixty-three, complained of gastric disturbances associated with progressive painless jaundice. No palpable masses were present. X-ray

examination showed a normal stomach and duodenal bulb. In the right lateral position a deformity was noted in the middle third of the descending duodenum. The position of the pylorus and duodenum was normal and the duodenal loop was not enlarged. The clinical impression was pancreatic tumor, but this was excluded by absence of an enlarged loop and forward displacement of the pylorus. Since primary tumors are rarely found in the duodenum, it was suggested that the tumor might have its origin from the ampulla of Vater, causing obstruction of the common duct and jaundice. The roentgen diagnosis was confirmed by operation and subsequently by necropsy.

Case 6.—A woman of sixty was admitted with progressive painless jaundice. Physical examination was negative. X-ray examination revealed a normal stomach and duodenum (Fig. 5). On examination in the right lateral position the stomach and duodenum also appeared normal, but between the bulb and descending portion of the duodenum was a constant pressure defect (Fig. 6). While at first it was thought that the jaundice was due to a pancreatic tumor, inasmuch as there was



Fig. 5. Case 6: Anterior view. Normal stomach and duodenum.



Fig. 6. Case 6: Right lateral view. Pressure defect of descending duodenum due to common duct tumor.

no alteration of the duodenal loop or displacement of the pylorus, this diagnosis appeared untenable. Because of the pressure defect in the duodenum where it is contiguous to the common duct, a diagnosis of common duct tumor was made. This would account for the obstruction and the consequent jaundice. The diagnosis was confirmed at operation.

Case 7.—A man, aged forty-eight, complained of painless progressive jaundice. No masses were palpable. X-ray examination of the stomach revealed no abnormal changes in contour, shape, or position (Fig. 7). In the right lateral position the pylorus and duodenum were found to occupy a normal position. The duodenal loop was not enlarged. In the segment of the duodenum just between the bulb and descending portion there was a pressure defect on the inner curvature (Fig. 8). By applying the same reasoning as in Case 6 the diagnosis of a common duct tumor was made and was confirmed by operation.

Case 8.—A fifty-year-old man complained of gastric disturbances. X-ray

examination revealed an extensive deformity in the contour of the stomach along the greater curvature, suggestive of a new growth of the stomach. In the right lateral position the stomach was found displaced forward and its posterior wall was ill defined. A gastric neoplasm, as a rule, does not displace the stomach. A tumor arising from the pancreas, however, might displace the stomach as well as invade and deform the adjacent gastric wall. A diagnosis of pancreatic tumor originating in the body was confirmed by operation and autopsy.

A retroperitoneal tumor will also displace the stomach forward, but in our experience such a tumor does not usually invade or deform the gastric wall.

Case 9.—A woman, fifty-two years old, complained of gastric disturbances. On physical examination no palpable masses were present. X-ray examination revealed a pressure defect in the stomach opposite the spine. In the right lateral position the stomach was found to be displaced forward. Evidently the mass was behind the stomach

in the region of the pancreas. Since the pressure defect was of small dimensions, the left kidney and spleen could be excluded. The diagnosis of a tumor arising from the body of the pancreas was confirmed by operation.

Case 10.—A woman of fifty-seven years complained of gastric symptoms. No palpable masses were found on physical examination. X-ray studies showed a normal stomach with the exception of moderate elevation of the pyloric end. The duodenum presented a good-sized diverticulum. A stricture was observed at the duodenojejunal flexure, which in addition appeared to be displaced downward so that it was separated from the greater curvature of the stomach.

A simple stricture of the duodenojejunal flexure could not account for the upward displacement of the stomach and downward displacement of the bowel. A tumor of the pancreas, however, arising in the region where it crosses the duodenojejunal flexure, might separate the stomach from the bowel as well as invade the latter so as to produce a stricture with secondary obstruction. The diagnosis of pancreatic tumor was confirmed by operation and autopsy.

Case 11.—A woman, aged fifty-four, complained of abdominal distress. On physical examination a mass was palpable in the left hypochondrium. The left diaphragm was somewhat elevated and its excursions limited. The base of the left lung showed several nodules suggestive of pulmonary metastasis. X-ray examination showed the stomach in normal position. The cardiac portion presented a large pressure defect (Fig. 9). In the left lateral position the posterior wall of the stomach was displaced forward, indicating that the mass was behind it. In the right lateral position the anterior gastric wall was found displaced backward, apparently as a result of enlargement of the left lobe of the liver. This case is rather complicated, presenting several abnormal changes. The mass behind the stomach might have been due to a spleen, left kidney, pancreas, or

retroperitoneal metastasis. The spleen was excluded because of the fact that the mass was retrogastric and not lateral and moreover did not displace the stomach to the right. The left kidney was excluded because it was distinctly outlined, and was displaced downward. The differentiation between a pancreatic tumor and a retroperitoneal tumor could not readily be made. A pancreatic tumor was suspected, however, with metastases to the liver and lungs. Operation and subsequent autopsy revealed a new growth of the liver with retroperitoneal metastases which were in close proximity to the pancreas and kidney. In this case the diagnosis was not quite correct, but roentgen examination made it possible to exclude the spleen and kidney and pointed to a lesion in the liver.

Case 12.—A fifty-five-year-old woman, complained of abdominal distress. On physical examination an oval mass, elastic in consistency, was palpable in the left lumbar region. X-ray examination revealed displacement of the cardiac portion of the stomach to the right, the fundus remaining in normal position (Fig. 10). In the left lateral position the stomach was found to be displaced anteriorly, indicating that the mass was behind it. The spleen was excluded because the fundus of the stomach was not affected. The left kidney was outlined on the plain view and was not enlarged. On account of the position and the elastic consistency of the mass it was thought to be a pancreatic cyst, and this diagnosis was confirmed at laparotomy.

CONCLUSION

Several representative cases have been described illustrating a method of differentiating tumors arising from the pancreas and its neighboring structures. A high degree of diagnostic accuracy can be achieved by the indirect method, which consists in the study of the stomach and duodenum and their relation to neighboring structures. These anatomical relationships are a constant factor under normal conditions. A knowledge of the characteristic variations exhibited by the



Fig. 7. Case 7: Anterior view. Normal stomach and duodenum; no change in contour, shape, or position.

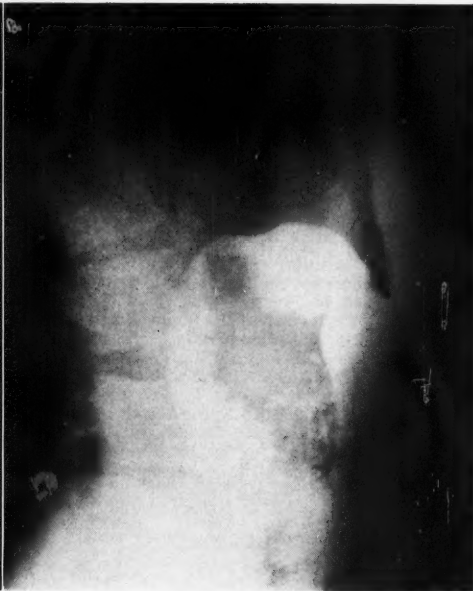


Fig. 8. Case 7: Right lateral view. Pressure defect of descending duodenum due to a common duct tumor.



Fig. 9. Case 11: Anterior view. Pressure defect of stomach due to the presence of a retroperitoneal tumor.



Fig. 10. Case 12: Anterior view. Pressure defect and displacement of stomach due to pancreatic cyst.

stomach and duodenum as a result of pressure by tumors arising from the neighboring structures has enabled us to determine the exact origin of many a new growth in the abdominal cavity. It has proved especially valuable in the diagnosis of pancreatic and common duct tumors.

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DISCUSSION

HARRY HAUSER, M.D. (Cleveland, Ohio): Dr. Brown has covered the subject of pancreatic tumors so well that there is little left for me to say. I should, however, like to emphasize a few of the points which he has mentioned. First, the knowledge of the anatomical relationship of organs in the neighborhood of the duodenal bulb is very important in arriving at a differential diagnosis of a lesion located at the distal end of the stomach. Second, the value of the lateral view cannot be over-emphasized.

Dr. Brown, it seems to me, arrived at his differential diagnostic points more from his lateral views than from anything else available in the study of his patients. In the lateral view he was able to differentiate pressure defects from the pancreas and retroperitoneal lesions posteriorly and lesions in the liver anteriorly.

I should like to add a few differential signs which Dr. Brown failed to mention. These signs are not original with me; they appear in the literature.

Feldman, in recent years, described the so-called inverted three filling defect on the medial side of the descending portion of the duodenum in early enlargements of the head of the pancreas. I think that is a very valuable sign, if we are to diagnose

cancer of the head of the pancreas in an early stage.

Engel and Lysholm have emphasized the importance of the prone lateral view. To obtain this, the patient lies on the abdomen and the film is made laterally, with a gas-filled stomach. If a tumor is present in the pancreas, it may project anteriorly into the gas-filled stomach and be readily visible.

Stenstrom has remarked on the changes revealed by the barium enema as indirect evidence of pancreatic disease; that is, the polyposis-like effect in the colon produced by fatty feces deposited on the colonic wall.

Byrd called attention to tumefactions which may enlarge the curve of the duodenum. These tumefactions may be situated retroperitoneally in lymph vessels and nodes, blood vessels and blood cells, nerves, fibrous tissue, and glandular tissue. This brings out the point that aneurysm of the pancreatico-duodenal or supramesenteric artery may produce a picture similar to carcinoma of the head of the pancreas.

Finally, I should like to say that anything that will improve our methods of the diagnosis of early cancer is well worth emphasis.

LEO RIGLER, M.D. (Minneapolis, Minnesota): I think Dr. Brown is to be congratulated upon a very illuminating discussion. Particularly was I impressed with the diagnoses of obstruction of the lower end of the common duct.

There are two points, however, which I should like to bring out. One is that tumors may occur in the head of the pancreas and produce jaundice without causing any enlargement. That undoubtedly accounts for the high percentage of cases of carcinoma of the head of the pancreas in which there are no findings such as Dr. Brown has brought out.

The second point is that if films are made with the patient in the usual prone position the stomach rises up, particularly in hypersthenic individuals, while the retroperitoneal portion of the duodenum is

relatively fixed. The simulation of a tumor may thus be easily obtained. We always make upright films under such circumstances; if in such films the distance between the duodenum and the stomach persists, much more significance may be attached to it than when it appears in the prone position only.

KARL KORNBUM, M.D. (Philadelphia, Pa.): I should like to ask Dr. Brown how many lateral films he makes. Failure to visualize any portion of the duodenum in a single film would seem to me not to be significant. I think also that the necessity of correlating the x-ray findings with the clinical facts requires emphasis. Painless jaundice, of course, gives away the diagnosis almost immediately.

JAMES T. CASE, M.D. (Chicago, Illinois): I believe Dr. Hauser referred to the inverted figure three sign as having been first described by Feldman. The inverted three sign, as remarked by Dr. Feldman in his own article, was first proposed by Dr. Frostberg.

JOSEPH T. DANZER (Oil City, Pa.): I should like to ask if Dr. Brown has had

any experience with an aneurysm of the abdominal aorta.

SAMUEL BROWN, M.D. (*closing*): In reference to Dr. Kornblum's remarks, I may say that the deductions are based entirely upon the roentgen findings. Only when the examination is completed are the clinical observations taken into consideration. If the two agree the diagnosis is evidently correct. In case of disagreement further studies are made before a final conclusion is arrived at.

Dr. Rigler is correct in calling attention to the upward displacement of the stomach in certain cases in the recumbent position. This often occurs in obese subjects. In order to overcome such changes in the position of the stomach the patient is also examined in the erect position.

I think the remarks of Dr. Case are correct. His recent paper on diseases of the pancreas is a most complete study and I would recommend it to the attention of radiologists.

Abdominal aneurysms, located as they are in the retroperitoneal region, displace the stomach forward. The presence of expansile pulsations usually makes the diagnosis of an aneurysm certain.

SURGICAL ASPECTS OF RUPTURED INTERVERTEBRAL DISC

WITH PARTICULAR REFERENCE TO THOROTRAST MYELOGRAPHY¹

By A. T. BUNTS, M.D., *Cleveland, Ohio*

From the Cleveland Clinic

DURING the past six years, since Mixter and Barr (1) emphasized the importance of ruptured intervertebral disc as a clinical entity, there have been a great number of published articles by neurosurgeons, roentgenologists, neurologists, and orthopedic surgeons dealing with this interesting and important subject. These contributions have led to an increasingly accurate understanding of the problem and have aided in focusing the attention of the medical profession upon a not uncommon pathological condition, which often incapacitates the patient and may be definitely relieved by surgical measures. When confronted with a case of intractable "lumbago," recurrent "sciatica," "lumbo-sacral strain," or "sacroiliac arthritis," the physician must take into consideration the possibility of a ruptured intervertebral disc and make an effort to confirm or disprove such a diagnosis.

It is important to bear in mind that a portion of the firm, elastic, fibrocartilaginous disc located between the bodies of any two vertebrae may herniate, protrude, or rupture posteriorly and encroach upon the neural contents of the spinal canal. Such herniations usually result from trauma, such as heavy lifting or sudden twisting movements of the body. If herniations occur above the level of the first lumbar vertebra, they give rise to symptoms and signs of spinal cord compression, simulating closely the clinical picture of tumors. When a lumbar intervertebral disc herniates posteriorly, the protrusion usually occurs at the site of least resistance, lateral to the mid-line, which is strongly rein-

forced by the tough posterior longitudinal ligament, with consequent impingement against the sheath of one of the nerves of the cauda equina near its exit from the main dural envelope. This condition gives rise to unilateral pain, which commonly radiates into one leg. Larger protrusions of a disc or free extrusions of fragments of the nucleus pulposus into the spinal canal may compress the main dural sac with its contained bundle of nerves, producing a clinical picture similar to that observed in tumors of the cauda equina.

Inasmuch as the great majority of disc ruptures occur in the lumbar region, particularly between the fourth and fifth lumbar vertebrae and at the lumbosacral joint, a brief clinical description of a patient presenting such a lesion will suffice. The patient frequently is a healthy young adult who complains of pain which often is localized in the lumbosacral region with radiation into one buttock, down the back of a thigh, into the calf, or along the lateral aspect of the lower leg and foot on one side. Not uncommonly there is a history of antecedent trauma in the form of heavy lifting or sudden violent twisting of the body; such a history, however, may be entirely absent. In some instances the patient has for many years had recurrent attacks of disabling "sciatica" and prolonged remissions with freedom from pain. The cause of such remissions is not clear, although it is conceivable that a small protrusion without complete rupture of the disc may produce edema and swelling of a nerve, and that these associated conditions may subside temporarily during enforced bed rest and limitation of exercise, only to recur following some later mild trauma. The patient often gives a history of having been subjected to various forms of treat-

¹ Presented before the Twenty-sixth Annual Meeting of the Radiological Society of North America, at Cleveland, Dec. 2-6, 1940.

ment, as braces, heat, fusion operations, chiropractic and osteopathic manipulations, vaccines and sera, and injections of various substances into the caudal canal or into the sciatic nerve. Examination often reveals a flat lumbar spine with spastic lumbar muscles, a list of the trunk away from the side of pain, limitation of flexion of the trunk, pain on straight leg raising, and hypesthesia over the lateral aspect of the lower leg or foot on the side of pain. In the presence of a rupture of the lumbosacral disc, there usually is a diminution or absence of the Achilles reflex on the side of pain, whereas a rupture of the disc between the second and third lumbar vertebrae may be accompanied by decrease or absence of the patellar reflex.

The absence of narrowing of an intervertebral space in the plain roentgenogram or the absence of an increased amount of total protein in the cerebrospinal fluid does not militate against the diagnosis of a ruptured intervertebral disc. When such findings are present in association with the more important physical signs, they may be considered as corroborative evidence in favor of the diagnosis.

In the study and care of these patients at the Cleveland Clinic close co-operation is maintained among the departments of orthopedic surgery, neurological surgery, and roentgenology. When the diagnosis of ruptured intervertebral disc has been made, operation is performed by one of the neurological surgeons. From September, 1937, to November, 1940, operation was performed in 70 cases, the great majority of which revealed varying degrees of herniation or rupture of a disc. Some showed hypertrophy of the ligamentum flavum with or without an associated disc rupture.

Contrast myelography is carried out before operation in every case. Lipiodol, the contrast medium which has been employed most widely, formerly was used at this clinic, but during the past two and one-half years it has been supplanted gradually by the use of thorotrast, as developed experimentally by Nosik and Mortensen (2) and applied clinically by Nosik (3). This

substance, a solution containing 25 per cent by volume of thorium dioxide, is at least as effective as lipiodol from a diagnostic standpoint. Because of its low viscosity, it has an advantage in that it may be removed almost entirely from the subarachnoid space by forced drainage of the cerebrospinal fluid. The principles of this form of myelography have recently been described by Nichols and Nosik (4), who state that 70 to 90 per cent of the injected thorium dioxide is recovered by forced drainage and that the residual quantity in the body of the patient represents a radium equivalent of alpha and gamma radiations far below the minimal toxic levels which have been reported.

Fluoroscopic studies and roentgen films are made immediately after the introduction of 6 to 10 c.c. of thorotrast into the spinal subarachnoid space between the first and second lumbar vertebrae. The patient's head always is kept elevated above the level of the lumbar spine in order to prevent the entrance of thorotrast into the cranial cavity. Immediately after the roentgen examination the patient is returned to his hospital bed, where forced drainage of the cerebrospinal fluid is carried out at once, following the technic of Kubie and Retan (5). In sixty to ninety minutes the fluid becomes clear and the drainage is terminated. Following this drainage the patient may be somewhat nauseated and may complain of headache, but these symptoms are not constant and often are minimal. If the diagnosis of ruptured intervertebral disc has been confirmed by contrast myelography, operation is performed on the same day. Air myelography has not proved to be of conclusive diagnostic value in our hands.

The technic of operation must be varied somewhat in order to meet the conditions which present themselves in the individual case. The principal aim is to gain adequate exposure of the anterolateral aspect of the spinal canal in the region of the herniated portion of the intervertebral disc. Although formerly it was customary to remove the entire laminae of two vertebrae,

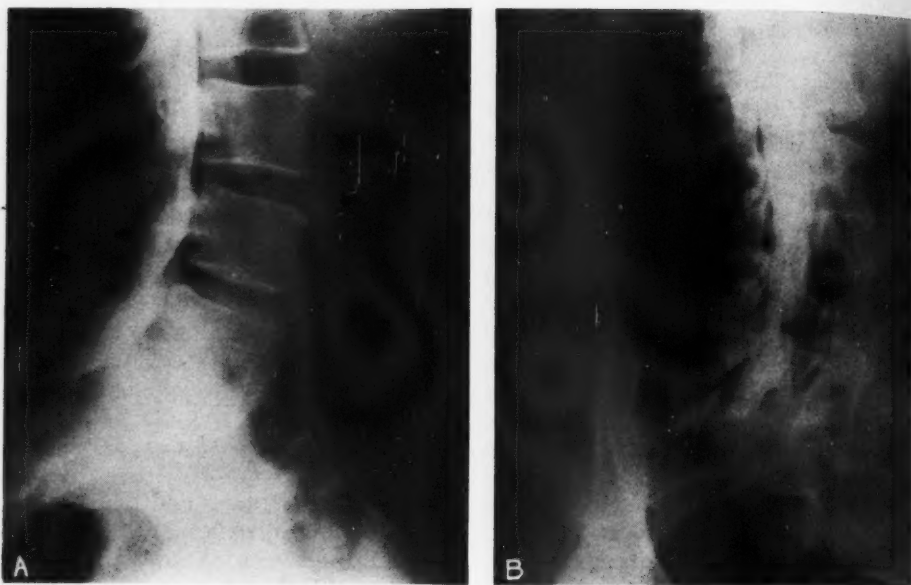


Fig. 1. Case 1: A. Lateral thorotrast myelogram showing defect in anterior contour of opaque medium between fourth and fifth lumbar vertebrae.

B. Oblique thorotrast myelogram showing defect at same level on left side.

it now is considered desirable to remove as little bone as possible. A partial removal of bone from one side of the laminae often permits satisfactory exposure, particularly in the presence of small disc ruptures. In rare cases, where the ligamentum flavum is thin and very little extradural fat and connective tissue are encountered, the protruded portion of cartilage may be removed without attacking the laminae. The surgeon's efforts must not be needlessly impeded by the desire to avoid removal of bone, however, and in certain cases of massive extrusion of cartilage into the spinal canal it may be necessary to remove the entire laminae of two vertebrae. Exposure is facilitated by removing the ligamentum flavum well out to the side of the spinal canal. Retraction of the dural sheath of a nerve reveals the site of the lesion, which impinges against the nerve or deforms the main dural envelope by external pressure. The lesion may vary in size from a small pea-sized nubbin of cartilage without complete rupture of the annulus fibrosus to the larger extrusions of white, shaggy elastic material from the

nucleus pulposus. A short transverse or cruciate incision through the capsule of the protruding nubbin may be followed by partial extrusion of an irregular, shaggy white fragment of fibrocartilage, which can easily be removed with forceps. No extrusion may occur, however, and the operator may find it difficult to obtain more than a few small fragments of cartilage even with vigorous use of a curette and forceps; in such cases the rupture has been incomplete. The nerve root should be free from pressure at the end of the procedure.

In my experience the operation usually may be performed extradurally, although occasionally, when the protrusion is very large or is located near the midline of the spinal canal, it may be approached more conveniently through a transdural incision. When lipiodol has been used for myelography, it is well to open the dura and remove as much of the material as possible by irrigation, after which the dura should be closed with a continuous silk suture. This procedure is not necessary after the previous drainage of thorotrast, but the surgeon should always open the dura if he



Fig. 2. Case 2: Postero-anterior thorotrast myelogram showing defect between fifth lumbar vertebra and sacrum on right side.



Fig. 3. Case 3: Postero-anterior thorotrast myelogram showing slight shortening of nerve sheath at lumbosacral joint on left side. Not definitely diagnostic of disc rupture.

suspects an intradural tumor or other lesion of the cauda equina. It is not necessary to reinforce the spine by a bone graft after laminectomy. Bleeding from the epidural venous plexus may be somewhat troublesome in a few cases, but it can be controlled satisfactorily by the application of muscle pledgets and compression, or by careful electrocoagulation.

With a view to clarification of some of the problems associated with contrast myelography from the point of view of the surgeon, the following selected cases are briefly presented. The history and physical examination suggested a protruded intervertebral disc in every instance except Case 11 and Case 12, where tumor of the cauda equina was considered to be the most likely diagnosis. In each instance the conditions found at operation are described from personal observation and are compared with the myelographic picture.

Case 1. Man, aged forty-two.

Thorotrast Myelogram.—The lateral film shows a definite defect in the anterior con-

tour of the thorotrast column between the fourth and fifth lumbar vertebrae. The oblique view shows a definite defect at the same level on the left side (Fig. 1, A and B).

Operative Findings.—The nerve sheath on the left side between the fourth and fifth lumbar vertebrae was swollen and displaced in a posterior direction by a smooth protruding nubbin of intervertebral disc. Incision of the capsule was immediately followed by partial extrusion of an irregular fragment of fibrocartilage, which was removed without difficulty. The fragment weighed 0.7 gm.

Case 2. Man, aged thirty-eight.

Thorotrast Myelogram.—In the postero-anterior and oblique films there is a definite defect in the contour of the thorotrast column between the fifth lumbar vertebra and the sacrum on the right side (Fig. 2).

Operative Findings.—The nerve sheath on the right side between the fifth lumbar vertebra and the sacrum was swollen and displaced in a posterior direction by a smooth protruding nubbin of intervertebral

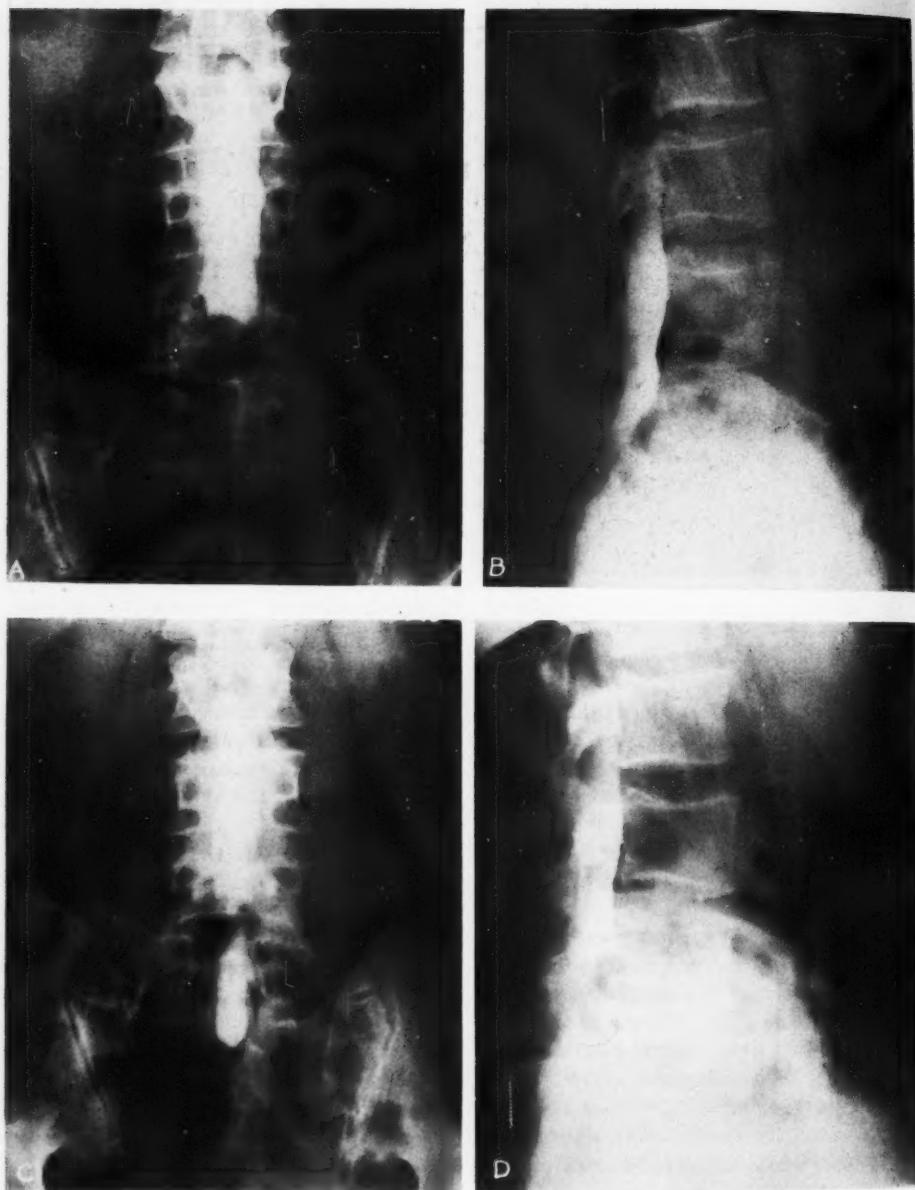


Fig. 4. Case 4: *A.* Postero-anterior thorotrast myelogram showing complete block of opaque medium at level of fourth lumbar vertebra.
B. Lateral thorotrast myelogram corresponding to film in Fig. 4-A.
C. Postero-anterior thorotrast myelogram made one-half hour later showing that some of the thorotrast has passed below the block.
D. Lateral thorotrast myelogram corresponding to Fig. 4-C.

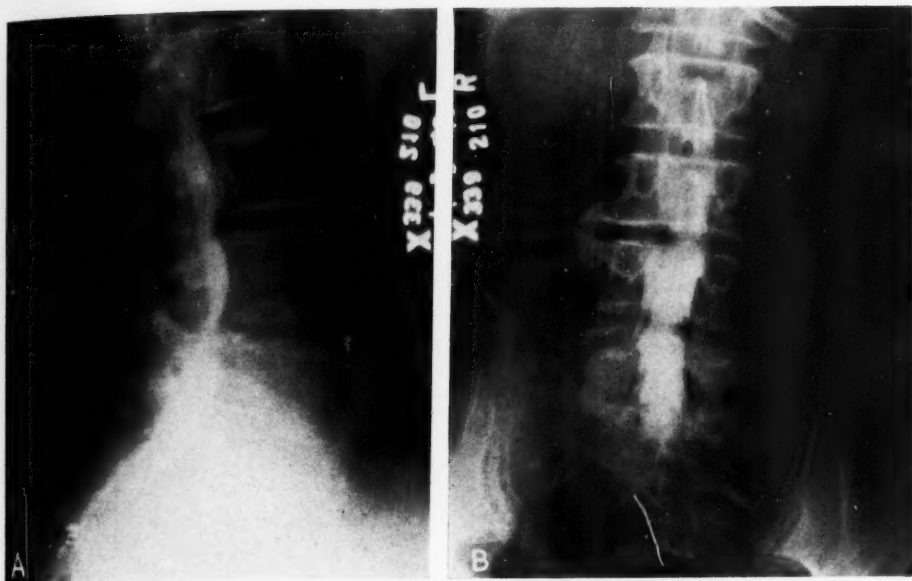


Fig. 5. Case 5: *A*. Lateral thorotrast myelogram showing defect between fourth and fifth lumbar vertebrae. *B*. Postero-anterior thorotrast myelogram showing incomplete filling of nerve sheath on the left side between fourth and fifth lumbar vertebrae.

disc. Incision of the nubbin was followed by easy removal of a shaggy fragment of fibrocartilage. The fragment was not weighed.

Case 3. Man, aged forty-two.

Thorotrast Myelogram.—The postero-anterior film shows an apparent slight shortening of a nerve sheath at the level of the lumbosacral joint on the left side, but this is not definitely conclusive of disc protrusion (Fig. 3).

Operative Findings.—There was an acute posterior bulging of the lumbosacral disc on the left side, where it impinged upon the nerve sheath. There was no complete rupture of the disc with extrusion of fibrocartilage into the spinal canal. After incision of the bulging portion of disc, a moderate-sized fragment of fibrocartilage was removed with some difficulty by means of forceps and curette. The fragment weighed 0.7 gm.

Case 4. Man, aged forty-six.

Thorotrast Myelogram.—The first films made soon after the injection of thorotrast show a complete block of the column of

thorotrast between the fourth and fifth lumbar vertebrae, suggesting the possibility of tumor (Fig. 4, *A* and *B*). Another set of films, made one-half hour later, shows that much of the thorotrast has passed beyond that level into the lower part of the dural sac; in these films there is a persistent large defect at the level of the interspace between the fourth and fifth lumbar vertebrae (Fig. 4, *C* and *D*).

Operative Findings.—There was a very large complete rupture of the disc with massive extrusion of fibrocartilage extending across the entire width of the spinal canal anterior to the dura. The dural sac was markedly displaced in a posterior direction and appeared to be almost entirely closed off by the compressive effect of the extruded cartilage. The mass was removed without great difficulty. The fragment weighed 3.1 gm.

Case 5. Woman, aged fifty-one.

Thorotrast Myelogram.—In the lateral film there is a definite defect in the anterior contour of the thorotrast column between the fourth and fifth lumbar vertebrae (Fig.



Fig. 6. Case 6: Postero-anterior lipiodol myelogram showing marked bilateral defect between fourth and fifth lumbar vertebrae due to hypertrophied ligamentum flavum.



Fig. 7. Case 7: Postero-anterior lipiodol myelogram showing defect in column of opaque medium on left side between third and fourth lumbar vertebrae.

5-A). The postero-anterior film shows incomplete filling of the nerve sheath on the left side at the same level (Fig. 5-B).

Operative Findings.—On the left side between the fourth and fifth lumbar vertebrae there was a very slight posterior bulging of the disc. Upon incision there was no extrusion of fibrocartilage under pressure, and with difficulty only a few small fragments were removed with forceps and curette. Weight of the fragments was not taken.

Case 6. Man, aged sixty-six.

Lipiodol Myelogram.—In the postero-anterior film a marked bilateral deformity was seen in the contour of the lipiodol column between the fourth and fifth lumbar vertebrae (Fig. 6).

Operative Findings.—There was an unusually thick and heavy ligamentum flavum overlying and compressing the dural sac at the level of the intervertebral disc between the fourth and fifth lumbar vertebrae. This structure extended well around

to the sides of the spinal canal. There was very little if any protrusion of the disc, and when its surface was incised, no cartilage could be removed.

Case 7. Man, aged sixty-seven.

Lipiodol Myelogram.—In the postero-anterior film there is a defect in the contour of the lipiodol column on the left side between the third and fourth lumbar vertebrae. This is suggestive of a disc rupture but is not conclusive (Fig. 7).

Operative Findings.—No protrusion of an intervertebral disc was found.

Case 8. Woman, aged twenty-two.

Thorotrast Myelogram.—In the lateral film there is a definite and rather acute deformity in the anterior contour of the thorotrast column between the fourth and fifth lumbar vertebrae (Fig. 8-A). The postero-anterior film shows no definite defect, although there is a questionable filling defect of the nerve sheath on the left side at the level of the lumbosacral joint (Fig. 8-B).

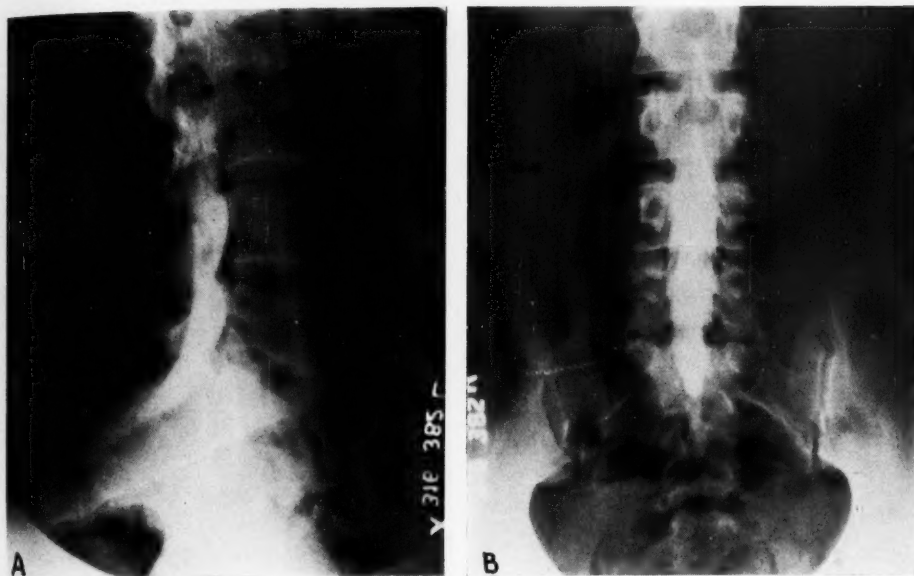


Fig. 8. Case 8: A. Lateral thorotrast myelogram showing rather acute defect between fourth and fifth lumbar vertebrae.

B. Postero-anterior thorotrast myelogram showing no definite defect between fourth and fifth lumbar vertebrae, although density of opaque medium seems decreased at that level. There is also a questionable filling defect of the nerve sheath on left side at lumbosacral joint.

Operative Findings.—There was a prominent mid-line elevation of the posterior margin of the disc between the fourth and fifth lumbar vertebrae. It was easily palpable through the dura. It was not a free extrusion of fibrocartilage, and only a few small fragments were removed with difficulty. No protrusion of the lumbosacral disc was found.

Case 9. Woman, aged fifty-two.

Thorotrast Myelogram.—In the lateral film there is a definite defect in the anterior contour of the thorotrast column between the fourth and fifth lumbar vertebrae (Fig. 9-A). The oblique film shows a defect on the left side at the same level (Fig. 9-B).

Operative Findings.—The dural sac appeared to be compressed from side to side. There was a white protruding nubbin of the intervertebral disc between the fourth and fifth lumbar vertebrae on the left side. Incision was followed by easy removal of a fair-sized fragment of fibrocartilage which evidently was ruptured completely and was

free from the remainder of the disc. The fragment weighed 1.3 gm.

Case 10. Man, aged twenty-six.

Thorotrast Myelogram.—In the postero-anterior film there is a large defect in the contour of the thorotrast column between the third and fourth lumbar vertebrae. This defect is larger on the left than on the right side. There is also a large bilateral defect between the fourth and fifth lumbar vertebrae (Fig. 10-A).

In the lateral myelogram there is a definite defect in the thorotrast column between the third and fourth lumbar vertebrae but there is no marked defect visible between the fourth and fifth lumbar vertebrae (Fig. 10-B).

Operative Findings.—Two definite protrusions of the discs were present between the third and fourth lumbar vertebrae on the left side and between the fourth and fifth lumbar vertebrae on the right side. Incision of the protrusions was not followed by extrusion of cartilaginous material, but small fragments were obtained

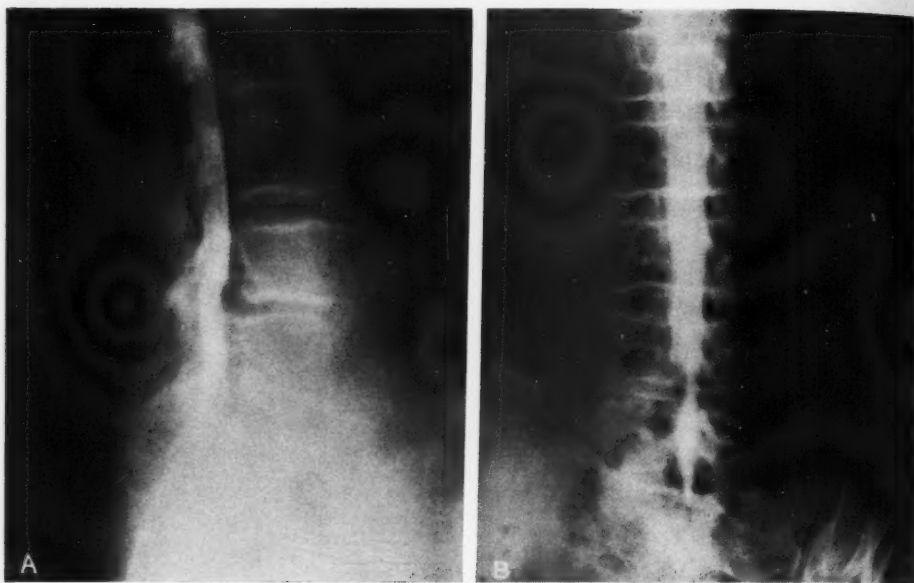


Fig. 9. Case 9: *A.* Lateral thorotrast myelogram showing defect in column of opaque medium between fourth and fifth lumbar vertebrae.
B. Oblique thorotrast myelogram showing defect on left side at same level.

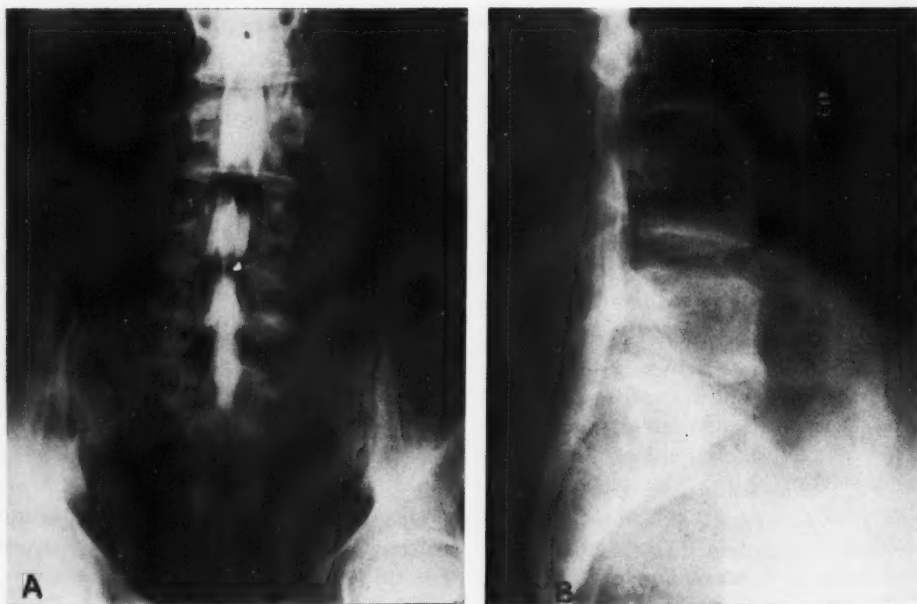


Fig. 10. Case 10: *A.* Postero-anterior thorotrast myelogram showing large defect between third and fourth lumbar vertebrae and also a large bilateral defect between fourth and fifth lumbar vertebrae.
B. Lateral thorotrast myelogram showing decreased density of opaque medium between third and fourth lumbar vertebrae but no definite defect between fourth and fifth lumbar vertebrae.

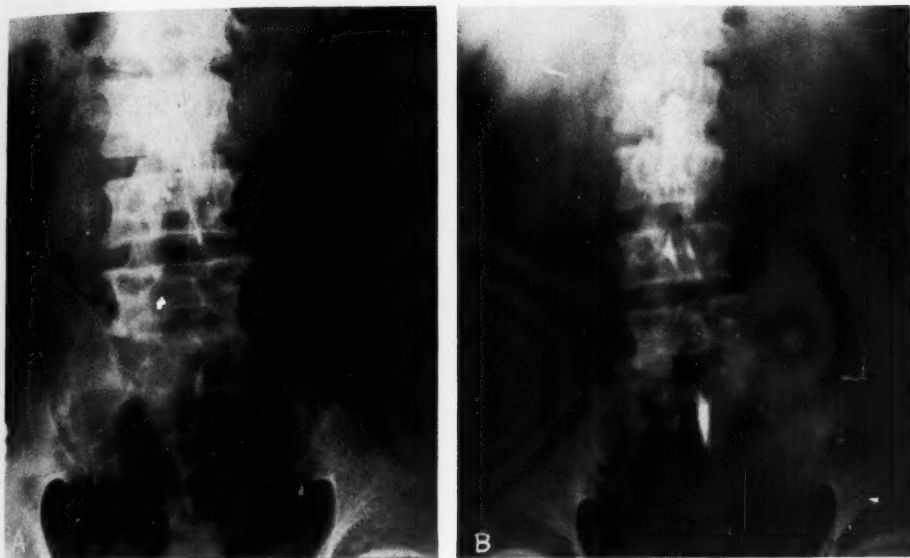


Fig. 11. Case 11: *A.* Postero-anterior lipiodol myelogram showing complete block of opaque medium between third and fourth lumbar vertebrae.

B. Film made twenty hours after previous film, showing that a small portion of lipiodol has passed beyond the block but most of the opaque medium still lies above the interspace between the third and fourth lumbar vertebrae.

with difficulty by means of curette and forceps. Complete rupture had not occurred.

Case 11. Man, aged fifty-three.

Lipiodol Myelogram.—Because it was impossible to introduce a spinal needle into the subarachnoid space through any of the lumbar interspaces, it was thought that this patient might have a tumor of the cauda equina. In order to localize the lesion definitely, 2 c.c. of lipiodol were injected into the cisterna magna. The descent of the oil was almost completely blocked at the level of the interspace between the third and fourth lumbar vertebrae (Fig. 11-A). A film made on the following day after the patient had remained in bed with the head elevated for twenty hours showed that a small quantity of lipiodol had descended to the sacral end of the dural sac, but that the major portion of the opaque medium still was blocked at the level of the interspace between the third and fourth lumbar vertebrae (Fig. 11-B).

Operative Findings.—The dural sac appeared to be much narrower than usual, particularly at the level of the disc between

the third and fourth lumbar vertebrae, where it was compressed by a free fragment of fibrocartilage lying in the spinal canal and unattached to the disc. Apparently the fragment had become separated completely from the disc and had been extruded into the epidural space.

Case 12. Woman, aged thirty-five. Case reported in full elsewhere by the writer (6).

Lipiodol Myelogram.—Because of the clinical picture, together with the complete spinal subarachnoid block by the Queckenstedt test, and yellow cerebrospinal fluid containing 3,500 mg. of total protein per 100 c.c., this patient was considered to have a tumor of the cauda equina. In order to localize the lesion accurately, 1 c.c. of lipiodol was injected into the cisterna magna. The descent of the oil was completely blocked opposite the upper part of the third lumbar vertebra (Fig. 12, *A* and *B*). A film made on the following day, after the patient had remained in bed with the head elevated for twenty-four hours, showed that none of the opaque medium

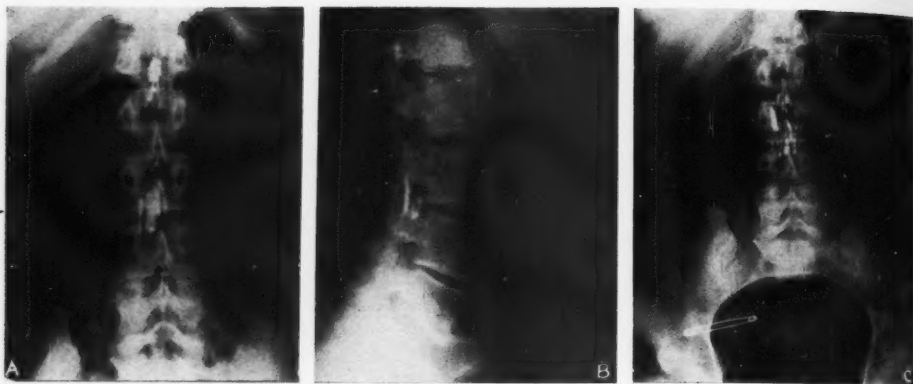


Fig. 12. Case 12: *A.* Postero-anterior lipiodol myelogram showing complete block of opaque medium opposite upper part of third lumbar vertebra.
B. Lateral lipiodol myelogram corresponding to the previous film.
C. Postero-anterior lipiodol myelogram made twenty-four hours later showing persistent block of opaque medium opposite upper part of third lumbar vertebra. Very large ruptured disc found at operation.

had passed below that level (Fig. 12-C). These roentgenographic observations appeared to confirm the diagnosis of tumor of the cauda equina.

Operative Findings.—An unusually large fragment of white shaggy fibrocartilage filled the entire spinal canal at the level of the body of the third lumbar vertebra and firmly compressed the dural sac and its contained nerves, blocking off completely the subarachnoid space. This mass had become separated wholly from the intervertebral disc between the third and fourth lumbar vertebrae and had been extruded into the epidural space, where it simulated a tumor. It was removed without difficulty. The fragment weighed 4.5 gm.

Although the above comparisons show that the contrast myelograms reflect with a fair degree of accuracy the pathological changes observed at operation, it sometimes is difficult to recognize the minor degrees of disc protrusion in the films. Thorotrast appears to fill the sheaths of the spinal nerves somewhat more completely than lipiodol, probably because of its lower viscosity. It seems possible, therefore, to identify more easily the small disc protrusions which compress the nerve sheath, but which are not large enough to deform the contour of the main dural envelope of the cauda equina. Even greater accuracy in

the interpretation of myelograms may be obtained in the future, if the roentgenologist can be summoned to the operating room when the lesion is exposed. It is then possible for the surgeon to demonstrate to him the exact nature of the pathological anatomy involved in the case. The surgeon should report his observations to the roentgenologist as accurately as possible. It is the responsibility of the surgeon to decide whether or not to operate in a given case, and in arriving at his decision he is guided not by the myelogram alone nor by the clinical history and physical examination alone, but by a careful consideration and analysis of all available data.

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DISCUSSION

JOHN D. CAMP, M.D. (Rochester, Minnesota): This presentation of the work that Dr. Bunts and his colleagues have done on the use of thorotrast is without question a definite contribution to the methods of diagnosing intraspinal protrusion of the intervertebral disc.

As Dr. Bunts has remarked, the ideal myelographic agent has not yet been found and all of those used to date have certain drawbacks. One of the great disadvantages of lipiodol is that it leaves footprints behind it. In other words, it is not resorbed; it remains indefinitely, as far as we know, in the spinal canal, and this I believe is the greatest objection to its use. Any substance which we put into the subarachnoid space is an irritant and it can be demonstrated, both by cytological studies and animal experimentation, that the reactions following ordinary lumbar puncture or the injection of saline solution may be equal in degree to the reaction following the injection of air, oxygen, thorotrast, or lipiodol. With these facts in mind, we have to select the medium to suit the case.

There are certain definite advantages in the use of air and it can be used apparently without any contraindications. The chief handicap in air myelography is that cephalad to the conus it is useful only in the presence of an obstructing lesion. Hence, if we are looking for small tumors in the thoracic or cervical region, air is of little aid. For the localization of tumors cephalad to the conus by means of contrast agents, lipiodol still remains the medium of choice, since thorotrast, when moved into these regions, is so diluted by spinal fluid that it is not readily visible. One of the limitations of thorotrast, if the quantity is kept to that advocated by Dr. Bunts, is that it will efficiently reveal only the lower three segments of the lumbar canal. If one is attempting only to determine the presence of a protruded disc and is not concerned about the possible presence of a tumor higher in the lumbar canal, which might be masquerading as a

disc clinically—and that happens once in a while—then I believe thorotrast to be a very satisfactory medium. I do feel, however, that tumors of the conus and tumors in the lower thoracic region of the spinal canal occur with just sufficient frequency, with symptoms simulating those of a protruded disc, that we cannot confidently exclude their presence by use of a medium which reveals only the lower two-thirds of the lumbar subarachnoid space.

I would like to emphasize that it is possible for patients with tumors in the cervical and thoracic portions of the spinal canal to have low back and sciatic pain. When we reviewed all of our cases of spinal cord tumor, we found that 30 per cent of the patients with tumors in the cervical canal and 50 per cent of those with tumors in the thoracic canal had low back or sciatic pain. By that I do not mean that those symptoms are due to the tumor; they may be coincidental but we should not let them mislead us, and I feel that, as far as possible, we should exclude lesions in the entire canal.

Thorotrast is an intense irritant in the subcutaneous tissues. I wonder if Dr. Bunts has ever had any thorotrast get into the epidural space. We have occasionally had that experience with lipiodol, but apparently the latter is not particularly irritating under such circumstances. I am curious to know whether the same thing applies to thorotrast.

The one case which Dr. Bunts presented in which a central protrusion was beautifully shown in the lateral view and only faintly visible in the anterior-posterior view as a shadow of rarefaction is a very common type of defect when the protrusion is central. The radiopaque medium passes over the hump of the protrusion in the prone position and the density of the medium will partially obscure the underlying filling defect. If the lateral and prone oblique positions are not used, it is possible to miss entirely a central type of protrusion.

MERRILL C. SOSMAN, M.D. (Boston, Mass.): I should like to have Dr. Bunts

give us a little more detail as to the forced drainage which he mentioned.

I should like to ask, also, whether fluoroscopy has been tried in localization of these defects, using thorotrast. Is the latter as readily visible as lipiodol with the fluoroscope?

ALEXANDER T. BUNTS, M.D. (*closing*): Dr. Camp spoke of the use of lipiodol and the possible advantages of its use in lesions above the conus, and I think that point is well taken. Whenever we have suspected a tumor, we have injected lipiodol into the cistern, allowing it to flow down the canal, whereas in those cases where we have definitely suspected a disc herniation, we have two years, been using thorotrast.

The masquerading of tumors as discs interests me. One of our patients presented a rather interesting clinical picture—stiff back, low back pain, and radiation of pain down one leg. A thorotrast myelogram showed a definite punched-out appearance of the column. There was some discussion in the x-ray department as to whether we were dealing with a disc herniation or a tumor, but I think the consensus was that, because of the clean-cut margin and the ovoid appearance of the defect, it was probably a tumor. At operation we found a neurofibroma of one of the nerves of the cauda equina.

Dr. Sosman inquired about forced drainage: As I said, the patient is returned to

his room in the hospital immediately after the x-ray work is completed. He is placed in bed on his side with the head of the bed elevated, and a large caliber encephalogram needle is inserted through the lowest lumbar interspace. An intravenous needle is placed in one of the veins in the antecubital fossa and 0.45 per cent saline solution is introduced into the vein—about 700 or 750 c.c. over a period of forty-five minutes to an hour. By that time there usually is a fair clearing of the cloudy appearance of the fluid and the intravenous needle is removed. We allow the lumbar needle to continue to drain for fifteen to thirty minutes thereafter until the fluid is quite clear. There is usually a return of about 150 c.c. of fluid. At the end of that period, the lumbar needle is removed and the patient (if myelography has disclosed a surgical lesion) is taken to the operating room.

As to the fluoroscope, we carry out a fluoroscopic study in every instance, but we do not depend upon it as the final diagnostic test. It is used as an aid in localization of the lesion, but for final diagnosis we depend upon the films. Of course, if the thorotrast shows a definite defect under the fluoroscope, we know that we probably are dealing with a disc herniation. In my experience, however, we have not been able to identify the condition as clearly with the fluoroscope as we have in films.

INVESTIGATIONS INTO THE SIGNIFICANCE OF THE SEDIMENTATION
REACTION AS REGARDS THE PROGNOSIS OF IRRADIATION
OF CANCER PATIENTS¹

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From the Radium Center, Odense, Denmark; Paul Jacoby, Director

AT the Radium Center of the Danish Society for the Campaign against Cancer in Odense, Denmark, it is possible to undertake a very close follow-up of the cancer patients treated. Because of the small size of the country it is possible for the patients to come for more or less frequent re-examination in the course of a number of years. Among the examinations which the patients undergo throughout the whole period, blood tests take a prominent place. During the last five years, regular blood tests have been taken on practically all the patients before and during treatment and at all subsequent re-examinations. From the material thus furnished, we confine ourselves here exclusively to the blood sedimentation reaction.

It is sufficiently well known that the blood sedimentation reaction is non-specific, and that the cause of increased sedimentation must be looked for in the parenteral resorption of albuminous substances in inflammatory or necrotic processes. It may, therefore, be difficult, if not impossible, to determine in a cancer patient whether an increase in the sedimentation reaction (SR) is due to necrotic processes in connection with tumor formation, or inflammatory processes of other nature. Numerous previous studies (Adams-Ray, Holboll, Lickint, Reichel, and others), have confirmed the significance of the SR in the diagnosis of cancer: in the differential diagnosis of other diseases it is very slight, as an investigation of the available material indicates, for which reason it is probably of little importance to go further into it. On the contrary, it

appears that SR in various ways is of no little significance in the determination of prognosis in cancer patients who have been under radiation treatment. Too much importance, however, must not be attached to the reaction before there has elapsed a certain time from the cessation of the treatment, as there are many factors during the treatment which may influence SR in one direction or another.

There is some disagreement among authors as to whether SR is increased or diminished by irradiation. Wulff, from his work at the Radium Center in Lund, Sweden, maintains that there is always an increase in SR after radium treatment of cancer uteri, but such a conclusion does not seem to us convincing. From our material, SR, apparently quite arbitrarily, has been sometimes increased and sometimes diminished; also in radium treatment of cancer of the uterus it seems to be incalculable whether the eventual increase of sedimentation is due to irradiation as such or to an aggravation of the inflammatory processes not due to irradiation.

The length of time that must elapse from the cessation of radiation treatment before we can advantageously evaluate the prognostic significance of SR is assuredly somewhat different. In our material, we have reckoned a year from the beginning of the treatment. By the period of observation we understand the time from one year after the beginning of the treatment until the last examination, which may thus be a period of from one to more than five years. The limit between normal and increased SR is reckoned at 15 mm. We shall here confine ourselves to a close observation of the two largest cancer groups

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—cancer of the breast and cancer of the uterus.

Breast Cancer.—In 59 of our breast cancer patients, we have determined the SR before the beginning of treatment (our standard treatment of breast cancer is pre-operative roentgen therapy, operation, and prophylactic roentgen irradiation after operation). Of these 59, 35 (60 per cent) had normal, and 24 (40 per cent) had increased sedimentation reactions. According to Steinhals' division into stages, we obtained the results shown in Table I.

TABLE I

	1	2	3	Total
Normal SR	12 (85 per cent)	16 (70 per cent)	7 (30 per cent)	35 (60 per cent)
Increased SR	2 (15 per cent)	7 (30 per cent)	15 (70 per cent)	24 (40 per cent)

It has been said that during radiation treatment, SR varies in a manner quite incalculable. In order to determine whether this variation might have, nevertheless, some prognostic significance, we have examined 68 patients before and just after irradiation, from which results we gather that the rise and fall occur just as often in the case of patients who are symptom-free as in the case of patients who later show metastases. (See Table II.)

TABLE II

	Metastases	Symptom-free	Total
SR Increased during Roentgen Treatment	18 (58 per cent)	21 (57 per cent)	39 (57.5 per cent)
SR Decreased during Roentgen Treatment	13 (42 per cent)	16 (43 per cent)	29 (42.5 per cent)

An account of the course of sedimentation reaction during the observation period seems to be of especial interest and prognostic significance. The patients are examined first at monthly, later half-yearly and yearly intervals. To a very large extent repeated roentgen studies of the lungs, vertebral column, and pelvis are made, and only after a very detailed examination are the patients regarded as

symptom-free. With the last examination there are 51 patients who are symptom-free from one to more than five years. In 35 (69 per cent) of these cases, the SR has been normal during the observation period. (See Table III.) From this it

TABLE III

Symptom-free in Years	Number	Normal Sedimentation During the Period of Observation
Over 5	6	6 (100 per cent)
4-5	6	5 (83 per cent)
3-4	11	7 (64 per cent)
2-3	11	7 (64 per cent)
1-2	17	10 (58 per cent)
Total	51	35 (69 per cent)

will be seen that the relative number of patients with normal sedimentation during the period of observation decreases, the shorter this period is. It is certainly not unreasonable to suppose that a greater part of the patients who have been under observation for a comparatively short time, and in whom the sedimentation reaction constantly increases, will later show recurrence and metastases, or perhaps already have concealed cancer foci. This supposition is supported by the sedimentation reaction in patients who are still alive with or have died from metastases. In these cases, the SR has shown a distinct tendency to increase during the period of control. Unfortunately, only 15 of these patients have been regularly examined; 12 have shown a constant increase of the SR during the period of observation, 2 a periodical increase, and 1 a normal SR (only one test). (Table IV.)

TABLE IV

Constant Increase in SR during Period of Observation	12
Periodically Increased SR	2
Normal SR	1 ? (single test)

In the case of patients whose sedimentation reaction is determined when they come for treatment of metastasis, the SR is nearly always increased. We have had 39 such patients. In 37 cases there was an increase, while in 2, both with node metastases, the reaction was normal. It follows

also clearly from this material, that SR is particularly increased in bone, pleura, and lung metastases. The record thus shows that SR seems to be of no little significance in the prognosis in breast cancer patients, and especially that a constant increase of SR for more than one year after the cessation of the treatment is prognostically a bad sign.

Uterine Cancer.—Our treatment of uterine cancer consists of two radium treatments in the uterus and vagina at intervals of from 10 to 20 days, in addition to protracted, fractionated roentgen therapy. Of our patients with uterine cancer there are 91 whose SR was taken before the beginning of the treatment. Of these, 44 (48 per cent) have normal SR and 49 (52 per cent) have increased SR. There are 20 of them with cancer corporis, and 71 with cancer colli uteri. The distribution of these patients may be seen in Table V.

TABLE V

<i>Cancer corporis uteri</i>					
Normal SR		8 (40 per cent)			
Increased SR		12 (60 per cent)			
	1	2	3	4	Total
<i>Cancer colli uteri</i>					
Normal SR	12 (67 per cent)	14 (56 per cent)	10 (43 per cent)	0	36 (50 per cent)
Increased SR	7 (33 per cent)	11 (44 per cent)	13 (57 per cent)	4 (100 per cent)	35 (50 per cent)

It follows, from the records, that SR is more frequently increased in patients with uterine cancer. This is not surprising in this particular form of cancer, which is often associated with non-specific inflammatory changes. Attention has already been drawn to the fact that the particular treatment of uterine cancer, with a blocking of the outlet from the uterine cavity for one or more days, often causes inflammatory reactions of more or less significance; changes which in themselves can exert an unfavorable influence. A record of the condition of SR, before and after treatment, has been made in the case of 33 patients. In these, the SR increased in 22 instances and decreased in 11. The rise, however, is found to be in general considerably greater than the fall—on an average 16 mm., while the decrease is on an average

8 mm. Nothing could be concluded with regard to prognosis from the SR during treatment. (Table VI.)

TABLE VI

SR Increased during Radium Treatment	22 (66.5 per cent) (about 16 mm.)
SR Decreased during Radium Treatment	11 (33.5 per cent) (about 8 mm.)

As in the case of breast cancer patients, our interest here is concentrated on the condition of SR in the patients who are symptom-free. At the last control examination of the patients, 39 are found to be symptom-free from one to more than five years. Nineteen (49 per cent) of these have shown normal SR during the observation period, and the remaining 20 (51 per cent) have shown a constant or periodical increase—the increase, however,

being very small, an average of 20–30 mm. (Table VII.)

TABLE VII

Symptom-free in Years	Number	Normal SR during the Period of Observation
More Than 5	3	
4–5	8	6 (75 per cent)
3–4	4	2 (50 per cent)
2–3	14	7 (50 per cent)
1–2	10	3 (30 per cent)

It is observed here, that the number of increased SR's is greater in uterine cancer patients than in breast cancer patients. While the normal SR may be considered as a particularly good sign, the slightly increased SR in this group of patients ought not to be taken, absolutely, as of unfavorable prognostic significance.

On the other hand, increased SR is

also often a bad omen here. Fifteen of the patients who showed recurrence during the period of control have been examined; 11 had constantly increased SR, 1 periodically increased, and only 3 normal SR (increased SR in 80 per cent). (See Table VIII.)

TABLE VIII

Constant Increase in SR during the Period of Observation	11
Periodical Increase in SR during the Period of Observation	1 (80 per cent)
Normal SR	3

Examination of SR at the time evidence of recurrence had appeared was made in the case of 14 patients. All of them had an increased SR—here it was a matter of considerable increase—on an average up

vestigation of the significance of SR, in skin and lip cancer, since it is not likely to be of great importance here. In the case of sarcomas, especially sarcomas of bone, and in many other forms of cancer, a constant increase in SR has also almost certainly proved to be a bad prognostic sign.

Finally, we shall mention the condition of SR in two diseases in which special means for the determination of prognosis are not needed, namely, leukemia and lymphogranulomatosis. The examination of SR in these two diseases has, however, shown quite interesting conditions with respect to differential diagnosis, as SR in leukemia is often normal for long periods, or only slightly increased at the beginning of treatment, whereas in lymphogranu-

TABLE IX

	1	2	3	4	Total
	0-15 mm.	16-25 mm.	26-50 mm.	Over 50 mm.	
Leukemia	8 (50 per cent)	2 (12 per cent)	3 (19 per cent)	3 (19 per cent)	16
Lymphogranulomatosis	4 (20 per cent)	1 (10 per cent)	5 (25 per cent)	10 (50 per cent)	20

to 53 mm. In the case of one patient, who had a large infiltration around the rectum, we were mistaken and supposed it to be a case of recurrence. Later it proved to be a case of inflammatory infiltration around a radium ulceration. Curiously enough this patient had a normal SR.

The records of uterine cancer patients thus show, as before, the prognostic value of SR.

We have not been interested in an in-

lomatosis we often find an increase of SR, and more frequently a considerable increase. We have examined 16 patients with leukemia, eight of whom have normal SR, and 20 patients with granulomatosis, only four of whom have normal SR. (See Table IX.)

It seems to us, that these investigations indicate the advisability of continuing the use of the sedimentation reaction in control examinations of cancer patients.

CASE REPORTS

CONGENITAL ATRESIA OF THE ESOPHAGUS WITH TRACHEO-ESOPHAGEAL FISTULA¹

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Congenital malformations of the esophagus are not as uncommon as is generally supposed, but frequently the failure to recognize these conditions early delays possible treatment until the newborn infant is so debilitated by starvation and aspiration pneumonia that therapy is futile and the condition is fatal.

The first recorded case was observed by Thomas Gibson of London in 1696. His description is remarkably similar to those of later authors. A case was reported by Martin in 1825, and in 1884 Mackenzie collected 63 cases from the literature. Plass (21) reviewed the literature up to 1919 and found only 136 cases, but in 1931 Rosenthal (24) stated that there were 255 recorded cases of congenital esophageal atresia, of which 205 were accompanied by a tracheo-esophageal fistula. He also presented a comprehensive survey of the pathology of the anomaly including histologic studies of four cases, and reviewed the various theories concerning the genesis of esophageal anomalies. To his paper the reader is referred for a more complete understanding of the embryology concerned.

The frequency of esophageal atresia is not known, and various estimates disagree. Reynolds and Morrison report that one case appeared in sixteen years at Bellevue Hospital prior to 1930, while Shukowsky saw one case among 50,000 newborn. Hirschsprung saw 4 cases in seven months; Brennemann observed 3 cases in one year; Ross saw 6 cases in ten years. Rosenthal (26) saw 11 cases in six years, all closely resembling one another, 3 of them occurring in two years in one New York hospital where 1,200 deliveries are made each year. Mixer reported 23 cases seen in ten years in the Boston Children's Hospital. O'Hare (19), in 1933, found 281 cases of congenital esophageal atresia, and 33 examples have been reported since that time.

The symptomatology is fairly constant; the child appears normal at birth but soon begins to regurgitate large amounts of mucus, becomes cyanotic, and coughs frequently in an attempt to clear the throat. The nasopharynx promptly refills with mucus after aspiration.

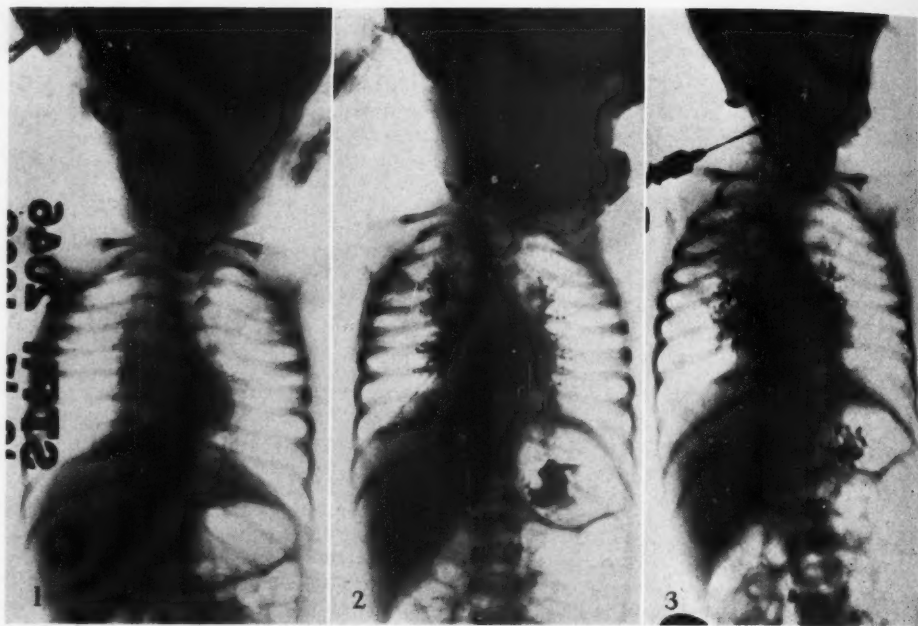
The infant attempts to nurse, but the milk is regurgitated. It may occasionally be retained for several hours, but when it is vomited no signs of gastric digestion are present. Only meconium is passed from the rectum. Weight loss and dehydration occur. This picture continues until death from starvation or bronchopneumonia occurs in ten to twelve days.

Clinical diagnosis can be confirmed by passage down the esophagus of a small catheter, which will stop when the obstruction is encountered, or by radiological examination with an opaque "meal," care being taken to prevent aspiration of this substance. The presence of a tracheo-esophageal fistula may be demonstrated by radiological examination following intratracheal injection of lipiodol; by bronchoscopic examination; by Farber's technic for examination of the meconium for the presence of cornified epithelial cells which come from the fetal skin and are swallowed *in utero*. (The meconium is washed with ether to remove fat, stained with gentian violet, and decolorized with acid alcohol). Presence of these epithelial cells suggests a passageway from the mouth to the anus (6).

The embryology of congenital anomalies is somewhat in dispute. Kreuter states that about the fifth week the tube-like esophagus is converted into a solid cord by epithelial proliferation and a lumen is later re-established by vacuolization of these cells. Failure to re-establish a lumen in one part of the tube would account for the atresia. According to Keith (12), lateral ridges are formed from the sides of the primitive esophagus at about the third week. These grow toward the midline and fuse, converting the single tube of the esophagus into a ventral trachea and a dorsal esophagus. Failure of development or faulty union of a part of this septum is held responsible for anomalies. Zausch explains the occurrence of anomalies by changes of tension in the embryo, the direction of pressure exerted by the heart anlage determining the type of anomaly produced. A genetic explanation is suggested by Mackenzie's case of a father who had three children by three wives. All the children were reported to have esophageal atresia. Rosenthal expresses the view that an early fundamental change in the entodermal cells is present and may be genetic in origin, possibly being related to defective development of the anterior end of the neurenteric canal.

Associated anomalies are frequent, the most common being atresia ani, which was present in 30 per cent of the cases reported. Others

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Figs. 1-3. Congenital atresia of esophagus: roentgenograms (ante-mortem) showing (1) barium in the upper end of the esophagus; (2) lipiodol in the upper esophagus and tracheobronchial tree, passing out through the tracheo-esophageal fistula on the right into the lower esophagus; (3) lipiodol in upper and lower esophagus, with fistula and tracheobronchial tree well outlined.

are malformations of the extremities, harelip, renal anomalies, malposition of the colon, patent foramen ovale, patent ductus arteriosus and other vascular anomalies.

Esophageal malformations are classified under 12 headings by McClellan and Elterich (15), those dealing with atresia being:

Obliteration of the esophagus.

- (a) Simple blind ending of the esophagus.
- (b) Blind ending of the esophagus with tracheo-esophageal fistula.
 - (1) Upper segment communicating with the trachea.
 - (2) Lower segment communicating with the trachea (the most common type).
 - (3) Both segments communicating with the trachea.

Case Report: A male negro child weighing 5 lb. 13 oz. was born to a nineteen-year-old multipara with one normal living child, after seventeen hours of labor, Oct. 6, 1939. The infant did not breathe at once, and when respiration did begin it was necessary to clean the throat and mouth of mucus repeatedly to prevent strangling. At St. Philip Hospital nursery the pharynx was aspirated, about two hours post partum, with a tracheal catheter and the child was returned to the mother,

who was given instructions to keep its head down at 30 degrees and induce crying to clear the air passages of mucus.

The following day she reported that the child had become cyanotic and regurgitated milk when it attempted to nurse. Bubbling râles were heard throughout the chest and the infant was again taken to the hospital and admitted to the Pediatric Service. It was somewhat premature, but well-formed. It attempted to nurse frequently but only a few c.c. were retained at each attempt. Frequent aspiration of the nasopharynx was necessary to prevent strangling.

Hartmann's solution and 5 per cent glucose were administered subcutaneously, and on the sixth day after admission, oxygen was given. Only meconium was passed per rectum and vomiting of bile-stained mucus occurred frequently. In ten days the child lost 10 oz. of weight.

Roentgen examination by Dr. F. B. Mandeville after a light barium meal showed an obstruction or occlusion of the esophagus at the level of the second dorsal vertebra, with a well-rounded pouch distal to the constriction. Lipiodol injection intratracheally showed a complete filling of the tracheo-bronchial tree with a tracheo-esophageal fistula extending

from the third dorsal level and the left posterior aspect of the trachea downward to the stomach. The distance between the esophageal segments was less than 1 cm. The lungs were clear at the periphery, with some increase in the vascular markings and irregular density in the hilum and inner trunk regions, compatible with bronchopneumonia.

Esophagoscopy examination by Dr. Porter Vinson revealed a congenital atresia of the esophagus of the usual type, the upper segment ending in a blind pouch, and the lower segment communicating with the trachea. Surgical consultation was requested.

Because of the poor condition of the child, a simple occlusion of the cardiac end of the stomach, with chromic catgut (40 day), and a gastrostomy were done by Dr. I. A. Bigger in preference to any attempt at plastic repair.

The child was fed through the gastrostomy tube and appeared to respond well in spite of the bronchopneumonia, but twenty-four hours postoperatively he suddenly became cyanotic and died.

At autopsy, the upper esophagus was found to be a dilated sac as visualized, extending downward along the trachea posteriorly to a point 1 cm. above the bifurcation, where it abruptly tapered down to a thin cord-like strand of connective tissue. The lower esophagus was a smaller muscular tube joining the tracheal bifurcation. The only associated defect was a vascular anomaly of the aortic arch, in which the common carotid arteries rose from a common stem as in the amphibia.

Various surgical procedures have been described by Bird (1), all of which appear to have been uniformly unsuccessful except that of Leven (13), in which the stomach was angulated out of the abdomen through a midline incision, a tube being introduced into the stomach toward the pylorus for feeding. Aspiration of the lower esophagus was carried out from below, the angulation preventing regurgitation of the stomach contents. One infant treated in this manner is said to have lived ninety-eight days and another fifty-three days, both dying of infections.

SUMMARY

1. Congenital atresia of the esophagus occurs more frequently than is commonly thought, but often is not recognized.
2. The most common type is associated with a tracheo-esophageal fistula.
3. Diagnosis can be made from the clinical syndrome and confirmed by roentgenological study.
4. One case is reported, conforming to the common type.

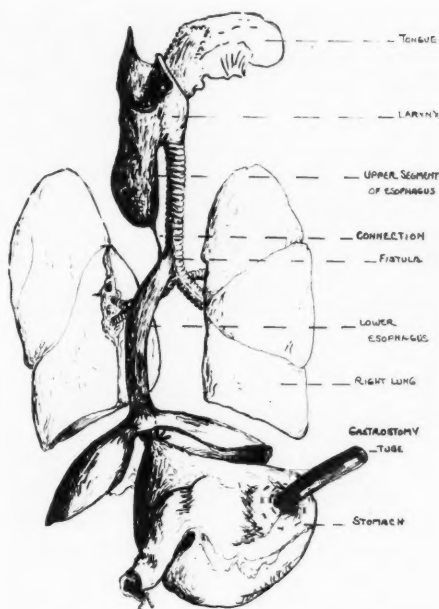


Fig. 4. Drawing of autopsy specimen showing the appearance of the tracheo-esophageal fistula in a posterior view.

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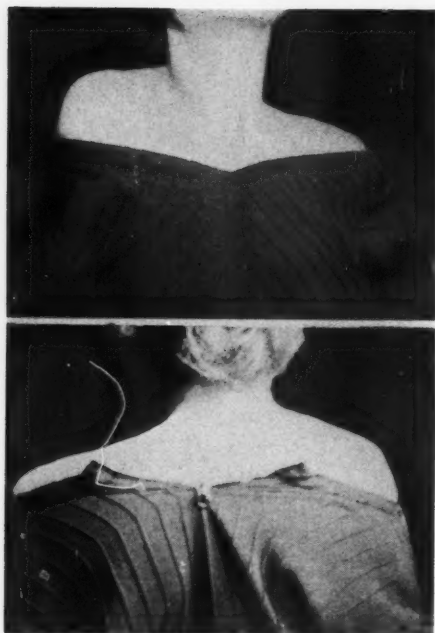


Fig. 1. Sprengel's deformity: Case 1.



Fig. 2. Sprengel's deformity: Case 2.

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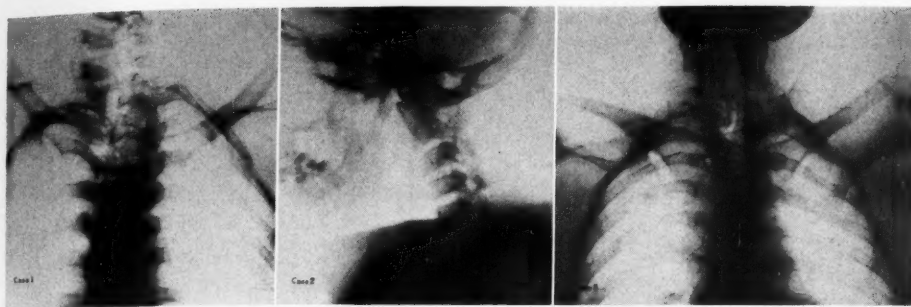
SPRENGEL'S DEFORMITY¹

By HENRY G. HADLEY, M.D., Washington, D. C.

¶ Sprengel's deformity, a striking abnormality involving one or both scapulae, was first described by Eulenburg in 1863 (1). It received its present name after Sprengel's description in 1891 (2). The affected scapula, more often the left (3), is rotated on its sagittal axis, so that instead of being parallel to the spine, the superior vertebral border is closer to the medial line and the inferior angle closer to the axilla. While this condition is present at birth, it is not always recognized before adult life.

This congenital elevation of the scapula is usually associated with other abnormalities, such as defects of the ribs, vertebrae, or muscles. Among these are fusion or malformation of the ribs or vertebrae. Defects of the cervical vertebrae are especially prone to cause the Klippel-Feil (4) syndrome of short neck, limitation of head movements, and growth of the

¹ Accepted for publication in October, 1939.



Figs. 3-5. Sprengel's deformity: Roentgenograms of Cases 1, 2, and 3.

hair low down on the neck. Scoliosis is found in less than half of the cases and is compensatory because of the attempt to straighten the back.

As Sprengel's deformity is usually unilateral, the patient has an asymmetrical appearance, the neck being thicker and shorter on the affected side. The mobility of the scapula is lessened and the movements of the arm are restricted. There are weakness and poor development of the muscles which normally hold the scapula, especially the trapezius (5). The maldevelopment with consequent altering of the shape of the scapula is due to improper muscular tension, as the traction of the muscles aids in shaping the bone during the growth process. Often there are defects in, or even absence of, certain muscles (6). The muscles attached are fourteen in number, namely rhomboideus major and minor, teres major and minor, pectoralis minor, coracobrachialis, deltoid, triceps, biceps, trapezius, omohyoideus, supraspinatus, levator scapulae, infraspinatus, subscapularis, serratus anterior (7).

The high position of the scapula is explained by failure of its normal descent in the embryo. The scapulae appear about the fifth week of embryonic development, at the level of the fifth cervical and first dorsal vertebrae. They gradually lengthen and descend to the normal position at the level of the second to the seventh dorsal vertebrae. The migration of the scapula is due to muscular actions which may be insufficient where the intra-uterine pressure is excessive or where the musculature is defective (8). The cause of the deformity, according to Sprengel, is abnormal intra-uterine pressure, although the frequent occurrence of bone and muscular defects in the shoulder and elsewhere indicate that the condition is frequently an anomaly of development. Changes in the size and shape of the scapula are due to improper or defective muscular tension. Normally there is a definite ratio between the length and breadth of the scapula. It was upon this fact that

Broca (10) based the scapular index, which he found to be 65.9 or a ratio of $\frac{100 \times \text{breadth}}{\text{length}}$.

There may be bone changes such as an exostosis or an articulation which may be bony or fibrous (9).

The treatment depends upon the condition which is present. Where there is a bony union, surgery must be performed. If the muscles only are affected, gymnastic methods are indicated.

CASE REPORTS

Case 1. Mrs. M. D., white, aged thirty-six, complained of pain in both arms. She had a marked difference in the height of the shoulders, the left being higher and closer to the neck. There was considerable loss of motion of both the neck and the left shoulder. X-ray showed spina bifida occulta of the lower five cervical and upper six thoracic vertebrae. Cervical rib and a wedge-shaped second thoracic hemi-vertebra with associated scoliosis were present.

Case 2. Mrs. C. B., white, aged thirty-seven, had an abnormally short neck with a very low hair margin; also a congenital dimple over the lower cervical vertebra, but no growth of hair at that point. She had considerable lack of motion of the neck with the head tilted somewhat to the right. X-ray showed the first and second as well as the fifth and sixth cervical vertebrae to be fused. There was also a spina bifida occulta of the sixth and seventh cervical and first four thoracic vertebrae.

Case 3. Mrs. C. M., white, aged forty-four, complained of pain in the left shoulder, which was higher and closer to the vertebrae than the right. There was marked limitation of movement of the left shoulder. X-ray examination showed a typical Sprengel's deformity with articulation of the left scapula to the first, second, and third thoracic vertebrae. The left shoulder was 7.5 cm. higher than the right, and 6.0 cm. nearer to the median line. The right scapula was 7.5 cm. from the median line. Spina bifida occulta of the first, second, and

third thoracic vertebrae was present and a scoliosis with the convexity to the left.

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"DISC-LIKE ATELECTASES": A SUPPLEMENTARY NOTE¹

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The production of disc-like atelectases by various forms of interference with respiration was discussed in RADIOLOGY, December, 1938. In that paper it was stated that except for interlobar thickening no other condition of which we know produces similar linear shadows in the pulmonary bases. A recent experience suggests that this statement should be amplified or perhaps corrected.

A white male, aged sixty-five (Hosp. No. 30927), was referred by Dr. George H. Miller with the clinical diagnosis of hepatic tumor. Roentgen examination (No. 8969) showed small varices in the lower end of the esophagus; an area of circular swelling round the papilla of Vater; a mass, the size and shape of an egg, arising from what appeared to be the lower



Fig. 1. Roentgenogram showing linear shadow crossing the base of right lung (arrows), suggestive of disc-like atelectasis.

surface of the left lobe of the liver, pressing upon the pyloric region; elevation of both halves of the diaphragm, with sluggish movements on the right side; and a horizontal shadow line, interpreted as a disc-like atelectasis, above the dome of diaphragm on the right. These findings were suggestive of both tumor and cirrhosis of the liver, esophageal varices being in favor of the latter, and the hepatic node of the former. The presence of a disc-like atelectasis was accounted for by the shallow breathing observed under the screen.

The patient died twelve days later. Autopsy (No. 955) showed a primary neoplasm involving the entire liver uniformly, permeating the inferior vena cava and metastasizing into the pulmonary vessels. The tumor resembled a hypernephroma, being composed of polygonal cells, interlobular and intralobular, with a cytoplasm rich in lipoids and with large hyperchromatic nuclei. A plug of tumor cells was found to extend through the inferior vena cava into the vessels of the lung. There were no pleural adhesions to account for the linear shadow seen during life; but on the anterior surface of the middle lobe, 2 cm. above its lower edge, was an indurated and retracted area almost linear, about 5×0.2 cm., which corresponded in size and location to the shadow. The area resembled a disc-like atelectasis macroscopically. Histologic examination, however, showed the induration to be due to metastatic tumor in the pulmonary vessels; there was no atelectasis.

Metastases of this kind seem to be rather uncommon, and it is doubtful whether they produce linear shadows in other cases. It would be difficult to decide whether the shadow seen during life did correspond to the metastases

¹ Accepted for publication in October, 1939.

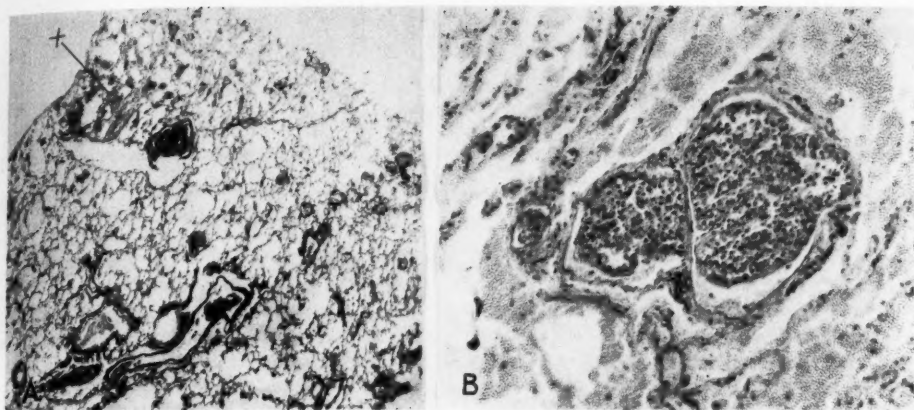


Fig. 2. Photomicrographs of pulmonary region corresponding in location to the linear shadow shown in Fig. 1. In A ($\times 3$) large blood vessels and bronchi are conspicuous at the lower left and small vessels filled with plugs of tumor metastases are seen in the upper half. Most alveoli are filled with air except for some which contain blood; the latter are in the upper left of the picture, around the metastasis (\times). Note retraction of pulmonary surface at \times . B. Higher magnification ($\times 120$) of area indicated by \times , showing two blood vessels (probably branches of one) filled with masses of tumor cells. The surrounding alveoli are filled with blood. Weigert and hematoxylin stain. (Courtesy of Drs. Edmund Mayer and Philip F. Sahyoun.)

found at autopsy, or whether it was due to a transient disc-like atelectasis no longer present at the time of death. Yet the close correspondence in size, shape, and localization between the roentgenographic and autopsy findings suggests that it is possible, or perhaps even probable, that the shadow line was due to the plugged vessels. The statement quoted at the outset should be amplified, therefore, by adding

that apart from interlobar thickening, plugged pulmonary vessels may perhaps occasionally produce linear shadows similar to those caused by disc-like atelectases.

I wish to thank Drs. Philip F. Sahyoun and Edmund Mayer for their co-operation and for permission to publish the autopsy and histologic findings in this case.

EDITORIAL

HOWARD P. DOUB, M.D., *Editor*

JOHN D. CAMP, M.D., *Associate Editor*

EXPLORING WITH X-RAYS

Emerson said that if a man built a mousetrap which was better than the mousetraps commonly used, the world would beat a path to his door. The truth of this thesis has been demonstrated over and over, but on looking closely, we are impressed by one essential prerequisite: The maker of the mousetrap must not keep his invention secret. Publicity, then, at which many are wont to look down their noses, is the very cornerstone of the structure of general information, and the means by which the store of that information can be disseminated.

Radiologists know that the art and science of the diagnosis and alleviation of disease are difficult; that long and arduous training is required, and that the well trained and skillful radiologist has much to offer in his capacity of consultant. But radiologists have been singularly reticent on this subject. As a result, the general public has a vague notion that "radiologist" means a person who has something to do with radios, and that "x-rays" are made by a sub-species of photographer. Certainly this misconception and this state of misinformation are highly undesirable and there has long been a general feeling that something should be done about it. Impressed by the tremendous influence of motion pictures on public thinking, numerous members of our national societies have suggested that this influence could be

put to work in behalf of our specialty, but the cost of making an educational film, and making it well, has proved an insuperable obstacle.

It is likely that no single effort will result in a general enlightenment of the public, but a long step toward solution of the problem has been taken with the production of the film "Exploring with X-rays." Produced by the General Electric Corporation with the cooperation and assistance of the American College of Radiology, the picture presents the discovery of the roentgen ray and the subsequent development of methods of producing x-rays and their application to medicine. The rôle of the radiologist as consultant is strongly emphasized. The film was made, acted, and directed by professionals and presents the story of Radiology with accuracy and with dignity. A 16-millimeter version with sound track is available for those who may wish to show it to school, church, college, club, or similar groups, and if the radiologists of America will avail themselves of the opportunity thus open to them much of educational value may be accomplished.

The film had its first showing before the Board of Chancellors of the College on Feb. 16. The College and the General Electric X-ray Corporation are to be congratulated on their joint achievement.

LOWELL S. GOIN, M. D.

Special attention is called to the fact that the next annual meeting of the Radiological Society will be held in San Francisco during the first week of December, 1941. The Society last met on the Pacific Coast eleven years ago in the city of Los Angeles.

A meeting rich in scientific interest is being planned by the officers of the Society and the California members may be counted on to make this a gala occasion. Further details of the meeting will be presented from time to time in these columns.

COMMUNICATIONS OF INTEREST

The following communications were sent to State Councilors of the American College of Radiology and secretaries of all regional radiological societies on March 21, 1941:

NYA HEALTH PROGRAM

In connection with what is apparently a rather hastily prepared "health program," the National Youth Administration proposes to provide a physical examination for some 500,000 youths between the ages of seventeen and twenty-four enrolled in the NYA program during the coming year.

The examination will include, in some localities, a routine roentgen examination of the chest. In others, roentgen examinations will be performed on positive tuberculin reactors. Regulations provide that "chest x-rays of NYA youth should be undertaken only where an experienced roentgenologist is available."

One of the expressed aims of the NYA health program is to develop "in youth an interest in improving their health by their own personal efforts." It has been indicated that existing health and medical facilities are to be used. Consistent with these principles, youths should be taught in connection with the project that medical service should be sought from private physicians instead of governmental agencies or free clinics. We suggest, therefore, that agreements be made with the director in each state to have youths referred to private radiologists in their offices or hospitals for examination.

Each state health program will be directed by an appointed physician who will be assisted by a full-time supervisor. The method for remuneration of radiologists participating in the project is a matter for negotiation between the radiological organization in each state and the director.

In response to an inquiry from this office, we have received the following advice in a letter from Dr. C. E. Rice, Director of Health of the NYA in Washington: "The State-wide health program is operated as a project with the State health department of the particular State acting as co-sponsor. Under this arrangement the health department contributes services which may be available. In many instances, there is a State mobile chest clinic which will assist in securing chest x-rays. In some instances chest plates may be secured through a local tuberculosis association where the association is operating a chest clinic. In either instance NYA can furnish the necessary films, but it is expected that because of a common interest in tuberculosis control, the remainder of the cost would be borne by the co-operating agency.

"As indicated in the Health Manual and referred to in your letter, NYA cannot obtain services on a contractual basis. This is because of certain legal limitations placed on expenditure of funds. However, services of physicians and specialists may be secured on a per diem basis, which is usually reduced to an hourly rate. The rate varies in different states from \$2.00 to \$4.00 per hour for examining physicians; roentgenologists may be reimbursed for service in the same

manner, with NYA furnishing the x-ray films and chemicals for developing and fixing the plates.

"Because of limitation in funds available for the health program, the States have been asked to keep the average expense of examination, including immunization and laboratory work, below \$3.50 per youth. To keep within this figure NYA will necessarily depend to some extent on the contribution of services from official and voluntary agencies as well as from individuals."

This means that the NYA will furnish films, but funds for remuneration of radiologists must be obtained from some "co-operating agency." Presumably this would be the local or state tuberculosis association or health department.

At its meeting last month the Board of Chancellors of the College adopted a motion to the effect that, since other examining physicians are to be compensated for their services, radiologists should not be expected to contribute their services at a loss in connection with the NYA health program.

We suggest the following procedure for the consideration of radiologists in your state:

1. Confer with the state health director of NYA, with an offer on the part of radiologists to co-operate to the fullest extent.
2. Arrange for roentgen examination to be done by private physicians instead of governmental agencies or eleemosynary institutions in accordance with the aim to educate the youths in good health practices and citizenship. Provide the director with a list of qualified radiologists willing to participate.
3. Agree upon an hourly rate for compensation of radiologists, and a method for computing hours consumed. Radiologists might keep a record of time devoted to examination of youths referred by NYA, or the total time might be computed according to an agreed period per examination.
4. Arrange for the distribution to participating radiologists of a supply of films purchased by NYA, the unused balance to be returned.
5. Agree upon a specified hour each day or a specified day each week, during which NYA youths would be accepted for examination. Unless someone is prepared to pay full fees for this work, radiologists should not be expected to neglect private patients in performing a service of a charitable nature.

Co-operation of the medical profession is essential if the NYA health program is to succeed. There seems to be no reason why radiologists should accept an arrangement that is not completely fair.

SELECTIVE SERVICE EXAMINATIONS

The following memorandum pertaining to Selective Service Examinations is submitted for your attention.

When the volume of service demanded of radiologists in connection with the examination of draftees is proving burdensome, two suggestions have been offered:

1. Medical Advisory Boards in each community may be provided with a list of qualified radiologists in

that area. Requests for roentgen examination might be rotated among the radiologists listed, or the Selective Service registrant referred for examination might be permitted to choose his radiologist from the list available.

2. Arrangements might be made with the various Medical Advisory Boards by which radiologists could choose the time when they will perform this charitable and patriotic service. A specified hour each day, during which Selective Service registrants could be examined with a minimum of interruption in their private practice, might be agreed upon among all participating radiologists. Registrants referred for roentgen examination would then be advised by the Medical Advisory Board that they must present themselves during the appointed hour to a specific radiologist or the one of their choice, according to which system is used for distributing this work.

*Excerpts from the minutes of the meeting of the
Board of Chancellors of the American College of
Radiology, Feb. 17, 1941*

A special reference committee appointed by the Chairman, and composed of Dr. E. P. Pendergrass, Dr. L. H. Garland, and Dr. E. W. Rowe, submitted the following report, which, upon a motion duly made and passed, was adopted:

"Several members and Fellows of the American College of Radiology have requested advice as to procedure and recovery of costs in connection with Selective Service Examinations. The Board of Chancellors of the College believes that as far as procedure is concerned, the following applies to the greater part of the country at the present time:

"Selective Service candidates or draftees are examined by local draft boards. Physicians on these draft boards who desire to have a draftee examined radiologically

may refer the candidate directly to the radiologist who is on his local Advisory Board or may refer him to the director of that board for permission for x-ray examination; in some instances he may utilize such other radiological facilities as are provided. X-ray reports are sent directly to the referring physician and the films are retained by the radiologist or at the source where they are made.

"The radiologist sends a statement for material costs incurred to the State Procurement Officer at the end of each month. Such statements must be countersigned by the Chief of the Medical Advisory Board and contain two certificates recording the fact that the fee charged is 'not in excess of that charged other patients,' and that the fee for professional and non-material costs is waived.

"The question of material costs schedule was considered by the Board of Chancellors. Correspondence reveals that many different schedules are in effect throughout the country at the present time. The Board is sympathetic with those physicians who believe that the Government should be expected to pay for medical services just as it pays for other professional and business services.

"However, as long as the official policy of the American Medical Association is that physicians' services should be donated to Selective Service Examinations, the Board feels that physicians practising radiology should do likewise; they waive not only their professional fees but also costs in excess of materials.

"Some twenty States have adopted a schedule known as the Iowa Material Costs Schedule, which is designed to cover the major portion of the costs of materials used and expended in diagnostic x-ray examinations. The Board believes that the precedent set by these states is sufficiently noteworthy that other states may now consider following it.

"Should the volume of work be unduly burdensome on any one radiologist, he may and perhaps should request the Chief of his Medical Advisory Board to see that other radiologists are appointed from his area."

MAC F. CAHAL
Executive Secretary

ANNOUNCEMENT

PAN-AMERICAN LEAGUE AGAINST CANCER

An organization which is to carry on in the Western Hemisphere the scientific and social work of the International Union Against Cancer has been incorporated under the laws of the State of New York as the Pan-American League against Cancer. Until recently the International Union Against Cancer was actively engaged in the fight against cancer on a world-wide scale, fifty-two countries being affiliated with the Union, which maintained headquarters at Paris.

The creation of the Pan-American League is due to the efforts of Professor Francis Carter Wood of New York, Professor Angel H. Roffo of Buenos Aires, and Mr. Boris Pregel, respectively, vice-president, member of the Board of Directors, and president of the Finance Committee, of the International Union Against Cancer, with the co-operation of many outstanding personalities in the field of cancer and members of the International Union in the Americas. Professor Francis Carter Wood headed the Organizing Committee of the new League and the presidency will be assumed by Angel H. Roffo, Professor of Cancerology at the University of Buenos Aires, Founder and Director of the Instituto de Medicina Experimental, the leading institution for cancer research in Latin America.

The Pan-American character of the new organization is evidenced by the fact that some twenty countries of the Western Hemisphere are represented on the Board of Directors either by outstanding Central and South American cancer specialists or by high officials of governmental health and hygiene departments of the countries concerned. In addition, the Argentine Government has extended its patronage to the Pan-American League against Cancer.

The aims of the new organization, as outlined in the certificate of incorporation are:

- (a) To promote and encourage the international fight against cancer.
- (b) To co-ordinate in the countries of the American continent scientific study and research in cancer and to publish and disseminate information thereon.
- (c) To engage in social welfare work in its relation to the problem of cancer.
- (d) To promote the establishment of na-

tional organizations throughout the Western Hemisphere to engage in similar activities.

The comprehensive program of the activities of the Pan-American League will include, it is hoped:

- (a) Publication of a Pan-American cancer journal to serve as a permanent medium of information on the activities of the League and its affiliated national organizations.
- (b) Organization and maintenance of a Pan-American center of information and statistics on cancer.
- (c) Establishment of a Pan-American system of fellowships, scholarships, endowments, and exchange of scholars and students.

Among its immediate projects are the organization of a *First Pan-American Cancer Week* to be held simultaneously in all the countries of the American continent on the pattern of the First International Cancer Week of 1938, which was observed simultaneously in forty countries throughout the world; the holding of a *Pan-American Congress for the Scientific and Social Fight against Cancer*, which it is anticipated will take place at Buenos Aires in 1942 under the chairmanship of Professor Angel H. Roffo and the honorary presidency of His Excellency, Dr. Roberto M. Ortiz, President of the Argentine Republic. The Congress will coincide with an *Exhibition* devoted to the scientific, social, and technical aspects of the fight against cancer, sponsored by the Pan-American League against Cancer.

BOOK REVIEWS

TUMORES PRIMITIVOS MALIGNOS BRONCO-PULMONARES (Cancer, Sarcoma, Linfogramuloma) [Primary Malignant Bronchogenic and Pulmonary Tumors]. By JULIO PALACIO, Professor Adj. de Clinica Medica de la Fac. de Buenos Aires, Director del Dispensario Municipal de Vias Resp. No. 2, and EGIDIO S. MAZZEI, Prof. Adj. de Clinica Medica de la Fac. de Med. de la Plata, Jefe de Clinica de la Catedra del Prof. Castex, Jefe de Seccion del Instituto de Investigaciones Aplicadas a la Patologia Humana, Laureates of the Academy of Medicine of Paris. Catedra de Clinica Medica del Prof. Dr. Mariano R. Castex, Hospital de Clinicas. A volume of 401 pages with 130

figures, including 4 colored plates. Published by El Ateneo, Buenos Aires, 1940. Price not given.

This monograph is Volume III of Biblioteca Argentina de Medicina Interna.

The authors have reported a study they have been making since 1933 in the Catedra de Clinica Medica of Professor Doctor Mariano R. Castex, in Buenos Aires, on 120 cases of primary malignant tumor of the lung. These have been thoroughly studied clinically, roentgenologically, and in most instances pathologically. The material is excellently presented and analyzed in such a way that the text can be intelligently read by those with only a minimal knowledge of Spanish. The authors have documented their own findings throughout, with frequent citations from the literature, which they list in a bibliography of about 1,200 references. Particularly noteworthy are some colored plates of pathologic and bronchoscopic specimens. Throughout the text the authors attempt to clarify the difficult points in the diagnosis of carcinoma of the lung and, of special interest to roentgenologists, they exemplify the value of the various roentgenologic procedures, the importance of which is correctly stressed. Nothing really new is offered in the way of treatment. Sarcoma of the lung—here lymphoblastoma is excluded from consideration—a very rare lesion, was encountered twice in the authors' series.

This monograph merits serious attention by clinicians, surgeons, radiologists, and pathologists, for it is a noteworthy contribution to the better knowledge of malignant pulmonary tumors, a subject of ever growing importance and complexity. It is to be hoped that it will soon be available in English translation.

ogist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 480 pages with 497 illustrations. Published by The Year Book Publishers, Inc., Chicago, 1940. Price: \$5.00.

The Editors of the 1940 Year Book of Radiology have again made available an excellent review of the more important radiologic literature of the year. In this new volume the foreign articles comprise 35 per cent of the contents as against 45 per cent in the 1939 issue.

The text is abundantly illustrated with excellent cuts and the publishers have been more successful in placing them adjacent to the descriptive text than in some of the earlier issues, which adds greatly to the usefulness of the volume. Editorial comments are appended to many of the abstracts, reflecting the ability and experience of the editors.

In the introduction to the diagnostic section attention is called to a number of the more significant papers, which is an aid in quickly locating abstracts in which the reader may be interested.

In the introduction to the therapeutic section the editor decries the fact that emphasis on war has tended to retard advances in therapy. This is especially true abroad. This introduction furnishes an excellent survey of the present status of cancer research and also of the application of radiotherapy to cancer and various non-malignant conditions.

The volume is carefully indexed both as to titles and authors, so that all material is easily available. It fulfills a definite need in Radiology and can be highly recommended.

BOOK RECEIVED

THE 1940 YEAR BOOK OF RADIOLOGY. *Diagnosis* edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital; Associate Editor, WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital. *Therapeutics* edited by IRA I. KAPLAN, B.Sc., M.D., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Associate Radiol-

ogist, Lenox Hill Hospital, New York City; Clinical Professor of Surgery, New York University Medical College. A volume of 480 pages with 497 illustrations. Published by The Year Book Publishers, Inc., Chicago, 1940. Price: \$5.00.

THE AMERICAN COLLEGE OF PHYSICIANS. *ITS FIRST QUARTER CENTURY*. By WILLIAM GERRY MORGAN, M.D., LL.D., Sc.D., M.A.C.P., Fellow (1916), Councillor and Regent (1916-29), Governor (1929-32), Secretary-General (1932-37), Vice President (1937-38), and Master (1940) of the American College of Physicians; Professor of Gastro-enterology and Emeritus Dean, Georgetown University School of Medicine, Washington, D. C.; Former President, American Medical Association. A volume of 276 pages. Published by American College of Physicians, Philadelphia, 1940. Price: \$2.00.

RADIOLOGICAL SOCIETIES IN NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying information to keep these notices accurate and up to date? Please send information to Howard P. Doub, M.D., Henry Ford Hospital, Detroit, Mich.

UNITED STATES

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd., Los Angeles.

Los Angeles County Medical Association, Radiological Section.—Secretary, Wilbur Bailey, M.D., 2007 Wilshire Blvd.; Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, J. Maurice Robinson, M.D., University of California Hospital. Meets monthly on third Thursday at 7:45 P.M. for the first six months at Toland Hall (University of California Medical School) and for the second six months at Lane Hall (Stanford University School of Medicine).

COLORADO

Denver Radiological Club.—Secretary, Paul R. Weeks, M.D., 520 Republic Bldg. Meets third Friday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary-Treasurer, Max Climann, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Elliott M. Hendricks, M.D., 314 Sweet Bldg., Fort Lauderdale. The next meeting will be at the time of the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—Secretary, Chester J. Challenger, M.D., 3117 Logan Blvd. The Society meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

LOUISIANA

Shreveport Radiological Club.—Secretary-Treasurer, W. R. Harwell, M.D. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, J. E. Lofstrom, M.D., 1536 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—Secretary, P. E. Hiebert, M.D., 907 North Seventh St. (Huron Bldg.), Kansas City, Kansas. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, D. A. Howell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society.—(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) Secretary, Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, W. James Marquis, M.D., 198 Clinton Ave., Newark. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—*Secretary-Treasurer*, L. J. Taormina, M.D., 1093 Gates Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—*Secretary-Treasurer*, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—*Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—*Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—*Secretary*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City.

Rochester Roentgen-ray Society.—*Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—*Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

OHIO

Ohio Radiological Society.—*Secretary*, J. E. McCarthy, M.D., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—*Secretary-Treasurer*, H. A. Mahrer, M.D., 10515 Carnegie Ave., Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer*, Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—*Secretary-Treasurer*, L. E. Wurster, M.D., 416 Pine St., Williamsport; The Society meets annually; time and place of next meeting will be announced later.

The Philadelphia Roentgen Ray Society.—*Secretary*, Barton R. Young, M.D., Temple University Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—*Secretary-Treasurer*, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

SOUTH CAROLINA

South Carolina X-ray Society.—*Secretary-Treasurer*, Malcolm Mosteller, M.D., Columbia Hospital, Colum-

bia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

TENNESSEE

Memphis Roentgen Club.—*Chairmanship* rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—*Secretary-Treasurer*, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—*Secretary-Treasurer*, L. W. Baird, M.D., Scott and White Hospital, Temple. Meets annually.

VIRGINIA

Virginia Radiological Society.—*Secretary*, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—*Secretary-Treasurer*, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee, Roentgen Ray Society.—*Secretary-Treasurer*, Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—*Secretary*, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—*Secretary*, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—*Secretary*, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—*Secretary*, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—*Honorary Secretary-Treasurer*, A. C. Singleton, M.D., Toronto.

La Société Canadienne-Française d'Électrologie et de Radiologie Médicales.—*General Secretary*, Origène Dufréne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—*Offices* in Hospital Mercedes, Havana. Meetings are held monthly.

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ROENTGEN DIAGNOSIS

THE CHEST

Mass Radiography. F. J. Bentley and Z. A. Leitner. *Brit. M.J.* 1: 879-883, June 1, 1940.

Due to the imminence of extensive militarization in the United States with accompanying mass medicine, this article should be of especial interest to all radiologists. The use of mass radiography is discussed mainly from the standpoint of its application to tuberculosis. The author, however, opens up possibilities for beyond this one phase.

Such methods of mass chest examination as screening, full-sized films, and paper rolls are discussed and disposed of as impossibly expensive, slow of operation, and difficult from the standpoint of storage. Credit is given de Abreu, who with the collaboration of Siemens made the first successful mass survey with screen photography in Brazil. (An article describing this survey has appeared in *RADIOLOGY* 33:363, 1939.)

The apparatus described consists briefly of an x-ray tube, high grade fluorescent screen, microgrid, and camera with a special lens. The units of the assembly are fixed in their relation to each other. The tube is placed 80 cm. behind the grid and screen, and the camera is fixed in the apex of a lead cone extending outward 85 cm. in front of the screen. A 35-mm. film is used. Exposure technic is 72 kv. at 80 ma., for 0.3 second, and from 200 to 300 examinations can be made in an hour. The assembly described costs in the neighborhood of \$5000 and 1000 chests can be photographed for approximately \$12.00.

A discussion of mass radiography in England, Brazil, the United States, and Germany indicates that from 1 to 2 per cent of each group examined will reveal tuberculosis that would otherwise have been missed. A still larger percentage of heart cases are discovered coincidentally.

It is pointed out that such data as are obtained by this method, especially during war time, might lead to a saving of public funds which would vastly exceed the cost of the apparatus plus the expense of operation.

The suggestion is made that radiologists should not attempt to set up a screen photography outfit with makeshift apparatus. Exact and precise machinery must be used to insure dependable results, and the personnel for its operation should be well trained.

MAX CLIMAN, M.D.

Roentgenologic Aid in Acute Infections of the Lung and Their Sequelae. H. B. Mulholland. *Southern M.J.* 33: 482-487, May, 1940.

Thirteen cases of pulmonary disease are reported in which the x-ray was the most important factor in making an early diagnosis. Atypical pneumonia especially in children, pericardial effusion, encapsulated empyema, and postoperative atelectasis are included. Tularemia is to be suspected in the presence of pleural

effusions or atypical lung involvement, especially when accompanied by a slow pulse and low blood count.

JOHN M. MILES, M.D.

Differential Diagnosis of Various Forms of Pneumonia in the Roentgenogram. Ludwig Stehr. *Mun-chen. med. Wchnschr.* 87: 531 and 556, May 17 and May 24, 1940.

The author considers frequently repeated roentgenograms highly desirable in cases of frank pneumonia.

Lobar pneumonia gives a typical picture with extensive infiltrative involvement, usually, though not invariably, of a whole lobe. In the early stages both clinical and roentgen findings are apt to be characteristic, while in the third stage the picture may become quite atypical. The presence of multilobar consolidations may produce density resembling pleural effusion except that the rib shadows can be more clearly distinguished. The homogeneity of the shadow, however, is not preserved more than three or four days after the crisis, and the patchy areas of resolution may be mistaken for lung abscess; they usually progress harmlessly to complete resolution.

In bronchopneumonia roentgen signs are frequently absent in the early stages; the course and roentgen signs are seldom parallel. The roentgen picture is of a more or less irregular shadow composed of many confluent loculi. When the individual nodules are small, the spotty character of the infiltration is more apparent. Distinction from tuberculosis is sometimes difficult.

Many patients recovering from an attack of "grippe," if studied by x-ray, show evidence of pneumonia; and since the proportion of such cases increases the more one makes a routine of raying these patients, the author advocates a routine roentgen examination of every convalescent from "grippe" or severe cold.

So far as complications of bronchopneumonia go, effusions and empyemas give characteristic roentgen signs. Small effusions, either interlobar or encapsulated against the ribs, may appear early in the disease and tend to regress more slowly than the lung signs. Such cases are often termed "pleuro-pneumonia." Abscess formation may occur. Unresolved pneumonia is a less frequent complication than in lobar pneumonia. Lymph node enlargements are quite usual in the early stages, but usually regress promptly. They are distinguished by their fuzzy borders from the enlargements of primary disease.

A miliary form of bronchopneumonia is seen, which is difficult to distinguish from miliary tuberculosis. The lesions tend to be somewhat larger and fuzzier, and confluence is not the rule. Since the roentgen signs are not characteristic, the clinical picture must usually decide the diagnosis.

Among the atypical pneumonias, pseudolobar confluent bronchopneumonia occupies an important place. Diagnosis is usually on clinical grounds, although the

presence of non-confluent patches near the involved region may offer a ground of distinction.

Friedländer bacillus pneumonia generally takes the form of bronchopneumonia. Psittacosis pneumonia takes a form midway between lobar pneumonia and bronchopneumonia. The contrast between the very slight clinical symptoms and the extensive roentgen findings is characteristic. The consolidations show a tendency to shift rapidly from place to place in the lungs.

Tuberculosis represents a serious diagnostic difficulty; indeed many cases of pneumonia are incorrectly diagnosed as tuberculosis. The more frequent occurrence of serous pleurisy is sometimes helpful as a differential point.

In conclusion the author observes that roentgen study alone will not give a final diagnosis in every case; and that knowledge of the clinical picture, course, history, laboratory findings, and bacteriological and serological studies is essential to correct interpretation. This is especially true in small children. If proper attention is paid to its limitations, however, roentgen study is an indispensable aid in the study of pneumonic diseases.

LEWIS G. JACOBS, M.D.

Importance of X-ray Interpretation in the Treatment of Pulmonary Suppuration. B. Blades. *Southern M.J.* 33: 565-569, June, 1940.

In the modern treatment of pulmonary suppuration more than a simple etiologic x-ray diagnosis is essential. The exact location and extent and character of the disease process must be known, both with relation to the chest wall and bronchopulmonary segments. A bronchogram in the routine posterior-anterior projection is insufficient. Oblique views of the chest or a combination of posterior-anterior and lateral views are needed to localize lesions. In addition laminagraphy is of distinct value.

JOHN M. MILES, M.D.

Roentgenologic Significance of Bronchomycosis. R. J. Reeves. *Southern M.J.* 33: 361-366, April, 1940.

Fungus infections of the lung are becoming more common and are widely distributed geographically. Infections with *Monilia*, *Oidium geotrichum*, *Oidium coccidioides*, *Torula*, and *Sporothrix*, as well as the more common actinomycosis and blastomycosis, have been reported.

Roentgenograms of pulmonary mycosis are not diagnostic of that condition; the picture resembles tuberculosis except that the extreme apices are not often involved. There may be a beading along the bronchi, a diffuse interstitial fibrosis, extensive cavitation, or a consolidation.

When a roentgenogram of the lungs is not entirely typical of tuberculosis or other common disease a search should be made for fungi in the sputum. Several

examinations may be necessary before the fungus is found.

Five cases are reported. Treatment, which includes x-ray therapy, is prolonged and improvement slow.

JOHN M. MILES, M.D.

On the Division of Lung Segments. E. Huizinga and E. Behr. *Acta Radiol.* 21: 314-325, June, 1940.

By means of bronchography, the subdivision of the left pulmonary lobes into segments was studied. Segmentation of the left upper lobe is very constant and is observed in about 98 per cent of all cases. Three segments can be ascertained in the upper lobe: an apical segment, a lower anterior segment, and a middle segment. The left lower lobe shows more variation, though an upper dorsal segment, a medio-dorsal, and a latero-ventral segment are rather constant. Shape and extent of the segments in the lower lobe are much more varied than in the corresponding upper lobe.

The clinical importance of these anatomical variations for the localization of inflammatory, cavernous, and bronchiectatic lesions is emphasized.

ERNST A. SCHMIDT, M.D.

Case of Pleural Cyst. W. Addey. *Brit. J. Radiol.* 13: 180-182, May, 1940.

A woman aged forty-nine complained of exhaustion, dyspnea, and palpitation. On x-ray examination an oval mass was seen projecting beyond the heart at the right costophrenic angle, in contact with the anterior chest wall. Lipiodol bronchography showed the bronchi crowded together in this area, but there was no bronchial obstruction, and no oil entered the mass. There was a slight increase in the latter after the passage of six weeks. At operation a cyst of the anterior layer of the pleura was found.

SYDNEY J. HAWLEY, M.D.

Cardiac Enlargement Followed by Regression in Non-Toxic Goiter. P. Cossio, E. B. del Castillo, and R. Finochietto. *Rev. argent. de cardiol.* 7: 65-74, May-June, 1940.

Cardiac enlargement in cases of non-toxic goiter is not even mentioned in current texts on cardiology. The authors report six cases of non-toxic goiter with cardiac enlargement, in which the heart size regressed following thyroidectomy. They dismiss Rose's theory—that enlargement is due to mechanical pressure on the neck vessels with consequent increased work for the heart—as incorrect. They attribute the hypertrophy to a short circuit in the blood flow due to an established arteriovenous connection at the goiter level.

They call attention to the prominence of the shadow of the superior vena cava and of the innominate veins, due to engorgement, as the most constant roentgen manifestation of arteriovenous short circuit in the region of the superior vena cava.

A. MAYORAL, M.D.

THE ABDOMEN

Abdominal Trauma. J. W. Levering. Pennsylvania M.J. 43: 1398-1404, July, 1940.

The conditions due to injury which may be encountered within the abdomen are, in their order of frequency, (1) mesenteric tears, (2) retroperitoneal hemorrhage, (3) liver tears, (4) fractures of the spleen, (5) bladder tears, (6) gastro-intestinal tract injuries, and (7) pancreatic injuries.

Demonstration of the presence or absence of free gas beneath the diaphragm by a film taken in the upright position is important. If this is not possible, a film should be taken in the lateral view with the right side up. Rupture of the retroperitoneal portions of the duodenum and colon may sometimes be diagnosed by demonstration of gas around the kidney.

Intravenous urography in cases of rupture of the bladder is of little value. Injection of radiopaque substances or air into the bladder may demonstrate a rupture.

JOSEPH T. DANZER, M.D.

Hiatus Hernia Simulating Cardiac Infarction. W. D. Reid. New England J. Med. 223: 50-52, July 11, 1940.

A fifty-two-year-old physician had repeated attacks of substernal pain, some quite severe, that were thought to be due to coronary disease, but no abnormality in the heart could be demonstrated even by the most searching tests. Finally consultation with a gastroenterologist brought forth the suggestion of a hiatus hernia, which was demonstrated roentgenographically.

There is one feature in the history of such patients that is of definite value, and very suggestive of hiatus hernia. It is the appearance of pain on lying down and more or less relief on assuming the upright position.

Hiatus hernia must be added to the list of those conditions that cause upper abdominal and substernal distress, and must be differentiated from coronary disease. Its frequency increases with the diligence with which it is sought.

JOHN MCANENY, M.D.

Sympathetic Neuroblastoma: Report of Case. O. B. Fesenmaier. Minnesota Med. 23: 244-246, April, 1940.

The sympathetic neuroblastomata, known also as neurocytomata or sympathoblastomata, are primary in the medulla of the adrenal or in sympathetic ganglia along the spine. The metastases, which always occur early, appear in the retroperitoneal nodes, the orbits, and the long bones. These metastases, firmly attached to bone, contain many bony spicules. The primary tumor, which invariably involves the left adrenal gland, varies in size and is usually palpable through the abdomen. The tumors occur for the most part in young male children, under the age of four.

In early cases, x-ray examination may reveal noth-

ing. Later, films of the skeleton show interesting findings. There may be intensive infiltration of the pelvis, femur, skull, and spine. A granular type of osteoporosis is present. There are destruction of bone and formation of new bone. Periosteal elevation with diffuse osseous infiltration may be observed.

Differential diagnosis must take into consideration the leukemias (especially aleukemic leukemia), chloroma, Ewing's sarcoma, myeloma, parathyroid dystrophy, rheumatic fever, tuberculosis, and hypernephroma. Neuroblastoma in children must always be suspected when pain in the bones, bulging of the eyeball, and an abdominal mass are present. The prognosis is hopeless.

A case is reported in detail.

PERCY J. DELANO, M.D.

DIGESTIVE TRACT

Congenital Atresia of the Esophagus. Mildred J. Ealing. Brit. M.J. 2: 83-84, July 20, 1940.

The author believes that congenital atresia of the esophagus is not as rare as is supposed. She points out that greater attention is paid to this condition in the United States than in England.

A typical case is presented, the salient symptoms being excess mucus in the pharynx, regurgitation, cyanosis, rapid pneumonic infection, with death in three days. Diagnosis may easily be made by roentgenoscopy with barium, as the esophagus ends in a blind pouch in the upper two thirds. Postmortem examination reveals a connection between the lower esophagus and trachea.

Q. B. CORAY, M.D.

Case of Congenital Atresia of the Esophagus. W. Addey. Brit. J. Radiol. 13: 179, May, 1940.

This is a case report of a child thirteen days old. The complaint was continuous vomiting. X-ray examination showed complete obstruction of the esophagus at the upper segment of the sternum. At autopsy, no opening below this point was found. There were no bronchial fistulae.

SYDNEY J. HAWLEY, M.D.

Gastric Disorders in the Services. Philip H. Willcox. British M.J. 1: 1008-1012, June 22, 1940.

The author opens his article by stating that gastric and duodenal disorders are the commonest medical causes for which soldiers are discharged from the service. Statistics from the first World War are presented. Various groups returned from France in the present war show a large percentage of gastro-duodenal complaints which in the majority of cases became apparent in the service. Investigation showed duodenal ulcer to be the commonest complaint, with gastric ulcer the next in order of frequency.

The overuse of tobacco is considered a very important etiologic factor, because of its apparent aggravat-

ing effect on gastroduodenal lesions. Improper diet is an aggravating factor rather than causative. The author seems to feel that army food is perfectly satisfactory if received by a stomach that is normal to begin with, but with the sudden change which occurs when an army takes the field, plus other disagreeable features of camp life, symptoms are likely to become apparent in a stomach already weakened. Oral sepsis was found to be present in one-third of the cases. X-ray examination led to the conclusion that both pylorospasm and chronic gastritis are of frequent occurrence in a stomach exposed to a war environment.

The conclusions are drawn that a great many people of army age have incipient ulcer of the stomach or duodenum and that war is the aggravating rather than the causative factor.

Q. B. CORAY, M.D.

Diagnostic Errors in Ulcerative Lesions of the Stomach and Duodenum. E. Freedman and H. D. Goehring. *Am. J. Roentgenol.* **44**: 48-58, July, 1940.

Despite better knowledge of gastroduodenal outlines and of the normal and abnormal mucosal pattern of the alimentary tract, roentgenologic errors are not infrequent, due mainly to incorrect interpretation of the findings rather than to failure in discovering the lesion.

There are many signs utilized in the differentiation between malignant and benign lesions of the stomach, based on morphologic appearance, size and location of the crater, and the appearance of the adjacent gastric wall. These signs, however, are not always reliable. The finding of an ulcer crater on the greater curvature does not justify the unequivocal diagnosis of a carcinoma. A benign prepyloric ulcer may cause an inflammatory reaction or mucosal swelling, imitating the roentgen appearance of malignancy or syphilis. The meniscus sign may appear in benign as well as malignant lesions. With reference to size of ulcers, carcinomas may be small, while giant craters may represent benign lesions.

Giant ulcers may occur in the duodenal bulb, and their appearance may imitate a normal or a slightly deformed bulb. These large ulcers of the bulb may simulate a diverticulum, but the stem-like connection with the lumen is missing, the wall is rigid, and there is usually a distal area of constriction. Knowledge of the existence of giant duodenal ulcer should lead to the correct diagnosis in a greater number of cases.

S. M. ATKINS, M.D.

Gastroscopic Findings in Patients with Duodenal Ulcer. T. Christiansen. *Am. J. M. Sc.* **200**: 61-68, July, 1940.

Seventy cases of non-stenotic duodenal ulcer were studied gastroscopically to determine the condition of the mucous membrane. No abnormalities were noted roentgenologically in relief studies of the gastric mucosa in these cases. Gastroscopically the mucosa ap-

peared normal in 30 per cent of the cases. A relatively benign superficial gastritis was the most frequent finding in the remainder of the cases. The more serious hypertrophic form was found several times; the erosive and hemorrhagic form was the least frequent.

Gastritis may involve all or part of the mucosa. If the involvement is partial, it is restricted to the proximal portion of the stomach. Antral gastritis is always part of a pangastritis; it was not observed as an isolated lesion in this series. The mucosal erosions are acute manifestations and may heal in a few days; transition to chronic gastric ulcer was not observed. These erosions may be responsible for acute gastric retention and for typical ulcer symptoms, which may subside as the lesions regress.

BENJAMIN COPLEMAN, M.D.

Inverted Duodenum: Its Clinical Significance, with Report of Fourteen Cases. M. Feldman and T. H. Morrison. *Am. J. M. Sc.* **200**: 69-74, July, 1940.

Inverted duodenum was seen 14 times in approximately 20,000 gastro-intestinal x-ray examinations, an incidence of 0.07 per cent. No characteristic symptoms were produced by this anomaly. Jaundice and diarrhea were not uncommon, however. The change of position or twisting of the bile ducts, or duodenal stasis, may cause backflow of the secretions into the pancreas. The cases are classified roentgenographically according to the segment at which the developmental error occurred. The duodenal bulb was never involved.

In the first type the entire duodenal curve is lost, with elimination of the angle formed by the first and second portions. The duodenum, shorter than normal, extends upward, to the left, and backward.

In the second type the duodenum is normal in length. The inversion occurs between the second and third portions. The third portion, instead of being transverse, turns sharply upward, toward and to the right of the second portion, crossing behind or above the duodenal bulb.

The duodenum is lengthened in the third type. There are marked redundancy and sagging of the first portion, and an absence of the normal duodenal curve. Most of the duodenum is situated to the right of the mid-line.

There is inversion of the duodenum with congenital non-rotation of the intestines in the fourth type. The entire duodenum is on the right side of the abdomen.

There is usually no delay in gastric emptying. Duodenal stasis is present, as a rule, in the last three types. Great care must be taken in the roentgen examination to demonstrate the entire course of the duodenum. Injection of the opaque material after duodenal intubation would be an ideal procedure.

Conservative medical management is usually sufficient to bring about symptomatic relief. Treatment should be directed to the associated conditions, when present.

BENJAMIN COPLEMAN, M.D.

Malignancy of the Small Intestine. C. W. Mayo. *West. J. Surg.* 48: 403-407, July, 1940.

A group of 108 primary malignant neoplasms of the small bowel seen at the Mayo Clinic from 1907 to 1939 is presented. The greatest number were in the jejunum (37 per cent). Only 25 per cent were diagnosed as small bowel neoplasms pre-operatively; 7 were discovered at autopsy. In 80 per cent of the cases the prime symptoms were those of intermittent small bowel obstruction and anemia with its concomitant weakness and fatigability. The anemia is comparable to that associated with malignant growths of the cecum.

Differential diagnosis of these and other obscure small bowel lesions has been facilitated in recent years by the use of the Miller-Abbott tube. The usual pathologic type was a circular stenosing adenocarcinoma; leiomyosarcoma was next in frequency.

Of 85 patients operated on before 1938, 25 or 30.1 per cent survived more than one year; of 66 operated on before 1934, 8 or 12 per cent survived more than five years.

SIMON POLLACK, M.D.

Perforated Jejunal Ulcer Following Partial Gastrectomy. W. Alexander Law. *Brit. M.J.* 1: 844-846, May 25, 1940.

Two cases of jejunal ulcer perforation following partial gastrectomy are presented. The author states that they are the only such cases in the records of the London Hospital for ten years, whereas there were 20 perforations at the same site following gastrojejunostomy.

The first patient was a forty-five-year-old woman originally treated surgically for duodenal ulcer. There were two other operations, each one consisting of a more extensive gastric resection. The salient features were persistent ulceration and persistent high acid in the stomach. The second patient was a thirty-year-old man who at the time of the report had undergone two gastric resections for a similar cause and with similar sequelae.

The principal etiologic feature in these cases was persistent high acidity. By gastroscopy a hyperplastic gastritis was found to be present, also. The author suggests that a subtotal gastrectomy should have been performed in the first place.

Q. B. CORAY, M.D.

Diverticulitis of the Colon. Clarence J. Berne and A. C. Pattison. *California & West. Med.* 52: 225-229, May, 1940.

The authors describe comprehensively the diagnostic and clinical problems associated with chronic and acute diverticulitis, both with and without abscess, and complicated by peritonitis, fistula, or stricture. The problem of diverticulitis is a common one and this paper is well worth reading. The conclusion is reached that there is a marked tendency toward spontaneous re-

covery in acute diverticulitis, though the outcome is usually fatal if general peritonitis exists. In such cases surgical intervention is unnecessary and not very helpful. If abscesses are formed they should be drained if progression occurs.

JAMES J. CLARK, M.D.

GENITO-URINARY TRACT

Frequently Unrecognized but Common Urological Lesions Detected Roentgenologically through Pathologic Processes. E. L. Shiflett. *Urol. & Cutan. Rev.* 44: 383-387, June, 1940.

The author discusses the interpretation of urological lesions detected roentgenologically and correctly states that plain urography is the most important single method of urinary tract x-ray examination.

JOHN G. MENVILLE, M.D.

Contour of Neurogenic Bladder (Hypotonic Type). M. Muschat and L. Edeiken. *Urol. & Cutan. Rev.* 44: 273-274, May, 1940.

By using intravenous urography the authors found that neurogenic bladders of the hypotonic type invariably show low lateral bulges of the walls, large horizontal and small vertical diameters.

JOHN G. MENVILLE, M.D.

Cystourethrograms: Roentgen Visualization of Urethra, Bladder, and Prostate. F. H. Colby and H. I. Suby. *New England J. Med.* 223: 85-92, July 18, 1940.

Cystourethrography consists in the injection of a radiopaque medium (lipiodol and tragacanth) into the urethra, following the usual procedure for sodium iodine solution and air cystography. The added feature of the thick radiopaque mixture permits the visualization of the urethra, sphincter, verumontanum, and prostatic enlargement if any. Information as to the size, type, and amount of obstruction caused by an enlarged prostate is of vital importance for deciding upon the type of operative procedure to be followed.

JOHN McANENY, M.D.

X-Ray Examination of Kidney Injuries with Special Consideration of Intravenous Urography. Ingvard Hareide. *Acta Radiol.* 21: 292-313, June, 1940.

The author reports 16 cases of renal trauma and discusses their roentgen characteristics without contrast medium: perirenal blood infiltration or, occasionally, enlargement of the kidney shadow may be seen. By means of intravenous pyelography, deformities and filling defects of the renal pelvis, ruptures with intrarenal and extrarenal urine infiltration, and decrease or loss of the kidney secretion may be demonstrated. About one-half of the reported traumas are what may be termed "sport injuries," being due to accidents while skiing, sleighing, bicycle riding, and boxing.

ERNST A. SCHMIDT, M.D.

Silent Urinary Calculi. J. A. Hyams and H. R. Kenyon. *Urol. & Cutan. Rev.* **44**: 230-235, April, 1940.

The authors illustrate calculi of various urologic organs which had been asymptomatic or had simulated disorders of other structures. Although they emphasize that urinary calculi are frequently symptomless, they also state that there is usually some indication that urinary tract pathology is present in those cases. It is suggested that all suspicious symptoms should be thoroughly investigated. The possibility of a calculus being the underlying factor in the presence of vague abdominal symptoms is also stressed.

JOHN G. MENVILLE, M.D.

Cystine Lithiasis: Clinical Study. H. J. Hammer and G. J. Thompson. *Urol. & Cutan. Rev.* **44**: 341-355, June, 1940.

In addition to presenting 14 new cases in detail, the authors give an excellent review of cystine lithiasis. They present a pre-operative roentgenogram showing huge bilateral cystine calculi and two post-operative films, one taken one year later, showing no evidence of calculi. The bibliography is extensive.

JOHN G. MENVILLE, M.D.

Management of Ureteral Calculi. W. W. Galbraith and A. I. L. Maitland. *Urol. & Cutan. Rev.* **44**: 164-168, March, 1940.

The authors have used with success uroselectan B in intravenous urography. They follow the radiographic technic originated in Sweden, namely compression of the ureters. A control film is taken, after which the dye is injected and a second film taken five minutes later. Compression of the ureters is then carried out by firm pads held in place and compressed by a wide linen band. Twenty-five minutes later a third film is taken. Thirty or forty seconds after this another film is taken, which will show a filling of the lower halves of the ureters.

JOHN G. MENVILLE, M.D.

Unilateral Multilocular Cystic Kidney (Report of a Case in a Young Child), W. A. Dakin. *Canad. M.A.J.* **42**: 531-533, June, 1940.

Cystic diseases of the kidney may be classified as follows: (1) the common type of polycystic kidney, affecting both sides, often referred to as congenital and hereditary, associated in some cases with cysts in the liver and other organs, and including both infantile and adult types; (2) simple cysts, such as (a) small multiple retention cysts associated with infections and localized tubular obstructions, regarded as acquired, and (b) large solitary cysts, unilateral as a rule, apparently acquired also; (3) large multilocular unilateral cysts.

The author reports the case of a girl of two complaining of pain referred down the left side of the abdomen, around the buttock, and down the left leg. Examination disclosed an abdominal mass, the size of a small orange, movable on palpation, just below the left

costal margin. The physician in attendance at birth had noted a "lump" in this region. Cystoscopic examination revealed absence of the left ureteral orifice. A pyelo-ureterogram of the right side was normal. Surgical exploration by the left lumbar route showed the palpated mass to be a tense cyst distended with fluid, with other large cysts loosely held together by coarse fibrous bands. No ureter was observed. The tissue attachment of the specimen to the fossa was a thin strand containing a small blood vessel. The wound was closed without drainage and the child made an uneventful recovery. There was no recognizable renal tissue in the mass. According to the author this places the origin of this congenital malformation at the 5-mm. stage of the embryo. It is at this time that the ureteric bud makes its appearance and gives rise to the ureter, pelvis, calices, and collecting tubules.

M. L. CONNELLY, M.D.

GYNECOLOGY AND OBSTETRICS

The Obstetric Pelvis: Is Manual Examination Adequate for Scientific Conduct of Labor? Comments on Roentgen Ray and Normal Measurements, J. P. Gardiner. *Ohio State M.J.* **36**: 752-755, July, 1940.

The author discusses the recent advances in roentgen pelvimetric methods with special reference to the work of Thoms, Caldwell and Moloy, and Hodges and Dippel. The important fact to him is that the "process of labor" is a continuous one and the unpredictable factors of (a) pelvic relaxation, (b) moldability of the fetal head, and (c) size of the fetus in relation to the pelvis all play an important rôle in most cases where there is no abnormal degree of pelvic contraction. These factors as a rule are not measurable by any x-ray study of the bony pelvis, as such a study is based on a static instantaneous picture. The expense of a complete x-ray examination is an added objection. In determining fetal anomalies, multiple pregnancies, etc., roentgen examination is, however, of value. The author sums up with the statement: "The obstetrician can still ordinarily rely for the conduct of labor on the information which he may obtain by the interpretation of the manual examination of the obstetric pelvis."

SIMON POLLACK, M.D.

Practical Aspects of Stereoscopic Roentgen-ray Pelvimetry. R. E. Tafel. *Pennsylvania M.J.* **43**: 1541-1544, August, 1940.

A series of 125 obstetrical patients on whom stereoscopic pelvimetry was done is reviewed by the author. He believes that x-ray studies are warranted where the clinical findings show significant shortening of the usual measurements; a promontory easily reached; a sacrosciatic notch admitting just two fingers; a straight, narrow subpubic angle; a sacrum which is flat or inclined forward. They also should be done in primigravidas with breech presentation or with posterior positions; women of "male" physical type; multigravidas with previous difficult labors; patients who

have had pelvic injuries. The precision stereoscope has been used in this series and its limitations are discussed.

The author believes that the responsibility for prognosis rests with the obstetrician, pelvimetry being only an additional aid to be used along with other clinical findings.

JOSEPH T. DANZER, M.D.

SKELETAL SYSTEM

Fractures of the Neck of the Femur in Childhood. J. C. Wilson. *J. Bone & Joint Surg.* **22**: 531-546, July, 1940.

From the textbooks one gains the impression that the treatment of fracture of the femoral neck in childhood is the same as in the adult, and that Legg-Calvé-Perthes disease frequently follows this fracture in younger patients.

A study of 10 cases of femoral neck fracture in children shows that a different type of treatment is required than in the adult and that, although changes in the femoral head do occur, they are not typical of Legg-Calvé-Perthes disease. The reproductions presented with the article show erosion of the femoral head, most marked on the superior aspect, with pronounced deformity of the head and distortion of the neck.

JOHN McANENY, M.D.

Pseudofractures: A Manifestation of Non-Suppurative Osteomyelitis. J. B. Weaver and C. B. Francisco. *J. Bone & Joint Surg.* **22**: 610-615, July, 1940.

Pseudofracture is a recently described entity characterized by a localized area of periosteal thickening and new-bone formation over what appears to be an incomplete V-shaped fracture, always in the upper third of one or both tibiae. There are usually moderate pain, tenderness, and possibly swelling, with tendency to heal promptly.

The present authors describe three cases in which the findings would suggest pseudofracture. The first patient had a pseudofracture in the right tibia and nine months later the same condition in the left tibia. Biopsy showed definite inflammatory tissue and led to a diagnosis of chronic osteomyelitis.

In the second, somewhat similar case there was a pseudofracture above the right external malleolus five weeks after a negative roentgenogram. Some time later the patient had pain and tenderness near the head of the other fibula, and this was also diagnosed as a pseudofracture.

The history and findings in the third case were similar.

It is the belief of the authors that the condition known as pseudofracture is really a low-grade chronic osteomyelitis, that it may occur in bones other than the upper tibia, and that decompression of the affected bone promotes rapid recovery.

JOHN McANENY, M.D.

Spontaneous Dislocation of the Atlanto-Axial Articulation Including a Report of a Case with Quadriplegia. M. J. Wilson, A. A. Michele, and E. W. Jacobson. *J. Bone & Joint Surg.* **22**: 698-707, July, 1940.

Following a review of the literature on spontaneous dislocation of the atlanto-axial articulation, a detailed history of a case is presented. This elderly patient had a cold, followed by pneumonia, during which quadriplegia developed. The atlanto-axial dislocation was discovered and treated by Crile traction, relieving the patient completely and reducing the dislocation.

JOHN McANENY, M.D.

Interposition of Sesamoids in Metacarpophalangeal Dislocations. P. D. Nutter. *J. Bone & Joint Surg.* **22**: 730-734, July, 1940.

This is a presentation of two case histories, detailing the facts and progress of dislocations at the metacarpophalangeal joint in which sesamoid bones became interposed between the two articular surfaces and interfered with reduction. This is a point to be considered by the radiologist and to be on the watch for. In these dislocations the position and number of sesamoid bones near the affected joint should be described.

JOHN McANENY, M.D.

Early Roentgenologic Signs in Some of the More Common Disorders of the Hip. J. B. Johnson and H. M. Anspach. *Southern M.J.* **32**: 1228-1234, December, 1939.

The authors conclude that, with the exception of congenital dislocation and slipping of the femoral epiphysis, early roentgen findings in disease of the hip joint are not diagnostic. Common to other conditions, in the early stage, are soft tissue swelling, bone atrophy, haziness of the joint space, and an intact joint cartilage. Serial examinations are necessary when these findings are present in order to make a definite roentgen diagnosis when the changes later become more marked.

Osteochondritis deformans juvenilis, which is often difficult to differentiate from tuberculosis, may be diagnosed by a slight increase in density of the affected bone in place of the local atrophy present in tuberculosis.

JOHN M. MILES, M.D.

Atrophic Charcot's Hips: Report of Five Cases. A. H. Conley and D. S. Miller. *J. Bone & Joint Surg.* **22**: 638-644, July, 1940.

The hypertrophic reaction of a Charcot joint has frequently been reported in the literature and is well known, but the atrophic type is less familiar. It is for this reason that 5 case histories of the atrophic type of Charcot joint are presented, together with several good reproductions.

All cases were diagnosed clinically, each having a triad of symptoms with a positive blood or spinal fluid. The ages ranged between forty and fifty-nine years. There were three females and two males.

Roentgenograms showed a characteristic loss of bone

substance and diminished reaction rather than the proliferative, irregular deposit of the hypertrophic type. Much of the bone is absorbed, the head and neck of the femur in some cases. Hypermotility of the joint is always present.

JOHN McANENY, M.D.

Osteochondritis Vertebralis (Calvé) Associated with Pathological Changes in Other Bones. R. Fawcitt. *Brit. J. Radiol.* 13: 172-178, May, 1940.

A case report of vertebral osteochondritis in a four-year-old child is presented, with serial films covering a period of about two years. Besides the original changes in the third lumbar vertebra, cystic changes were found in the upper end of one humerus and the upper end of one femur, and there was fusion of the second and third cervical vertebral bodies. The child also had a renal calculus.

SYDNEY J. HAWLEY, M.D.

Tuberculosis of the Large Long Bones of the Extremities. W. B. Carrell and H. M. Childress. *J. Bone & Joint Surg.* 22: 569-588, July, 1940.

In the English literature there are 32 reported cases of tuberculosis of the large long bones, but a questionnaire brought to light 74 unreported cases. These form the basis of this contribution.

The tibia and femur are the most frequently affected large long bones, but some patients have more than one bone involved. The age of onset is variable, from six months to seventy-five years, but the largest number of cases occurred in the twenty-to-thirty-year age group, showing therefore that the disease is one of adult life rather than of childhood, as formerly believed.

The duration of symptoms was from a few days to forty-four years, but more than half of the entire group had symptoms for more than one year, and 19 for over two years. Of the entire group, 25 had pulmonary tuberculosis, 7 had spine involvement, 5 involvement of the skull, and 11 joint involvement.

In the differential diagnosis syphilis, pyogenic osteomyelitis, coccidioid infection, Jüngling's disease and Boeck's sarcoid, and tuberculosis must be considered.

In syphilis, congenital or acquired, the characteristic lesion is a heavy dense infiltration of bone through the cortex, marked subperiosteal bone formation, and a tendency to obliteration of the medullary cavity. Sometimes there is bowing of the long bone, and at times cavity formation.

It may be extremely difficult to differentiate Brodie's abscess and Garré's disease from tuberculosis of the long bones. Recourse must be had to bacteriologic studies.

Many workers point out that it is impossible to differentiate between coccidioid and tuberculous bone involvement and that bacteriologic studies are necessary for this.

Multiple cystic lesions of the metacarpals, metatar-

sals, and phalanges believed to be of tuberculous origin, were described by Jüngling. Boeck's sarcoid is another tuberculous lesion. Both these conditions are believed to be due to a non-virulent form of tubercle bacillus.

Roentgenographically three types of tuberculosis of the long bones are recognized. (1) The encysted type shows definite cystic formation in the metaphysis, with but slight bone reaction; grossly there is a soft shell of bone enclosing soft grayish granular material with central caseation. (2) The atrophic type shows metaphyseal atrophy and expansion due to periosteal bone formation. (3) In the infiltrating type there is periosteal reaction, bone sclerosis, and extensive involvement of the shaft. Grossly, the cortex is heavy and dense, and there is much subperiosteal new bone. The cavity contains caseous material and bone sand.

JOHN McANENY, M.D.

Tuberculosis of the Knee: A Follow-up Investigation of Old Cases. R. C. Murray. *Brit. M.J.* 2: 10-12, July 6, 1940.

The author presents a valuable survey of tuberculosis of the knee joint, his purpose being to establish a means of prognosis and evaluate the different symptomatology which occur in this disease. From a collection of 2,922 cases of five or more years' duration 124 were picked at random and traced.

The analysis is made under the three headings: synovial, focal articular, and focal extra-articular. The first represents 30 per cent of the series. One of this group has died of phthisis, 10 have full range of motion and 8 limited motion; in 6 unsound ankylosis is present, in 6 bony union; 1 had an amputation, and in 1 the disease is still active. In the second and largest group the mortality is high; 21 per cent have died. Thirty-nine per cent of this group have a sound ankylosis; cure in the form of a movable joint has occurred in only 2 per cent. The third or extra-articular group comprised only 7 per cent of the series. The disability was low, 71 per cent having recovered with normal knees.

Treatment is discussed and the importance of roentgenography is pointed out.

Q. B. CORAY, M.D.

Isolated Tuberculosis of the Spinous Process of a Vertebra. R. L. Anderson. *J. Bone & Joint Surg.* 22: 741-744, July, 1940.

This is the first case report in the American literature of isolated tuberculosis of a spinous process of a vertebra. In all, 12 cases have been reported in the foreign literature. There is usually a painful onset, followed by a period of disability and subsequent abscess formation. Roentgen changes appear late. There does not seem to be any characteristic to distinguish tuberculosis from a pyogenic osteomyelitis of the spinous process.

JOHN McANENY, M.D.

Ewing's Tumor (Hemangio-endothelioma; Endothelial Myeloma; Solitary Diffuse Endothelioma): A Problem in Differential Diagnosis. Henry W. Meyerding and George A. Pollack. *Minnesota Med.* 23: 416-423, June, 1940.

Ewing's tumor is not as rare as is frequently suggested. It formed 26.9 per cent of primary malignant lesions of bone recently studied by Meyerding. In the authors' series of 114 cases, 66.8 per cent of the patients were less than thirty years of age; 71.9 per cent were males, 28.1 per cent females.

The middle of the shaft of a long bone is the site of election. The femur is most commonly involved. The most frequent localizing factor is trauma, as is also true of osteomyelitis, from which differentiation is important.

Pain is an early and the most characteristic symptom of Ewing's tumor. Nocturnal exacerbations render sleep fitful and contribute to the generally "run-down" appearance of the patient, but pain-free intervals occur, varying from days to months. Swelling of the part with local tenderness to pressure and an elevated oral and local skin temperature are common to both Ewing's tumor and osteomyelitis, but in the latter are usually more marked. Acute rheumatic fever in its early stages may also simulate Ewing's tumor.

The tumor begins in the endothelium of the blood vessels in the bone marrow, and the bone becomes widened as a result of invasion of the cortex, which presents a moth-eaten appearance. A reaction of periosteal proliferation occurs with deposition of successive layers of new bone, as each in turn is destroyed by the advancing tumor process. This gives the characteristic onion-skin-layer appearance seen in the roentgenogram. This appearance may be closely simulated by osteomyelitis and even by osteogenic sarcoma.

When doubt exists as to the true nature of the lesion, biopsy should be resorted to. Not infrequently at operation a milky fluid exudes from the lesion and further convinces the surgeon that he is dealing only with osteomyelitis.

Confirmatory evidence may be had by a therapeutic test with irradiation. Desjardins has maintained that the rapid melting away of these tumors with x-ray therapy is an even more accurate diagnostic test than is biopsy.

Surgery, irradiation, and Coley's toxins must all be considered in planning treatment.

Case reports are included.

PERCY J. DELANO, M.D.

Osteoid-Osteoma: Further Experience with this Benign Tumor of Bone. H. L. Jaffe and L. Lichtenstein. *J. Bone & Joint Surg.* 22: 645-682, July, 1940.

Since the original contribution on the subject of osteoid-osteoma by Jaffe, his series of cases has increased to number 33.

Clinically, the tumor has a predilection for adolescents and young adults, the majority of cases occurring

between ten and thirty years of age. Males are more frequently affected than females. The tumor has been found in the long bones and vertebrae, but not as yet in ribs, innominate bones, or skull.

The chief complaint is pain, which is persistent, even keeping the patient awake at night, and usually of long duration—several months to two years—before hospital admission. There may be localized swelling of the affected part, but no evidence of inflammatory reaction.

The roentgen picture is the most valuable single diagnostic guide. Two features are to be observed. One is the osteoid-osteoma proper, which is represented by a rarefied area in the bone about 0.5 to 1.0 cm. in diameter and sometimes is surrounded by a lighter area, a millimeter or so in width. The second feature is the extensive and marked reaction about the tumor, consisting of bone sclerosis.

The osteoid-osteoma may be found either in the cortex or spongy part of the bone. In the former location, it is represented by an area of lessened density, but in the spongy bone, the focus is very opaque.

This lesion is likely to be misinterpreted as an area of chronic osteomyelitis surrounding a bone abscess, or as an annular sequestrum in a chronic osteomyelitis. Syphilitic osteoperiostitis or sclerosing osteogenic sarcoma will also come under consideration.

From a study of their 33 cases the authors conclude that the focus should be removed in its entirety, including its bony bed, and the entire specimen studied pathologically. It has never been found possible to obtain cultures from the tumors. Most of these growths have been diagnosed as sclerosing non-suppurative osteomyelitis of Garré, but a review of Garré's original papers will demonstrate that an entirely different pathological condition was in his mind.

This extensive paper gives a detailed history, physical findings, roentgen and pathological reports for 8 cases of osteoid-osteoma. Many good reproductions are presented, and proof of the contention that the condition is a bone tumor and not an infectious process is offered.

JOHN McANENVY, M.D.

Roentgenologic Bone Manifestations in Certain Generalized Diseases of Infants and Children. W. D. Anderson and J. G. Hughes. *Southern M.J.* 33: 660-663, June, 1940.

Roentgen studies of the skeleton are recommended as an aid in the diagnosis of several generalized childhood diseases. At birth or shortly after, syphilis, osteopetrosis, fragilitas ossium, or achondroplasia may be manifested. Later, rickets, scurvy, xanthomatosis and hypothyroidism present characteristic bone changes. Chronic poisoning with heavy metals, such as lead, can be verified by a roentgenogram of the long bones. Two important types of anemia, sickle-cell anemia and erythroblastic anemia, may sometimes be differentiated from other forms on the basis of the x-ray picture. An excellent summary of the x-ray findings

for each of these conditions is included and the importance of roentgen examination for early diagnosis and doubtful cases is emphasized.

JOHN M. MILES, M.D.

Compressions of the Vertebral Bodies during Convulsive Therapy. E. Friedman, A. L. Brett, and E. C. Vogt. *New England J. Med.* 222: 704-710, April 25, 1940.

This is a study of 75 patients who received convulsive therapy and were examined radiographically for compression fractures of the vertebrae. Eleven showed evidence of spinal compression.

Several facts are brought out by this study. In the first place, convulsive therapy is usually applied only in persons who have been ill or inactive for some time with a resulting decalcification of bone—atrophy of disuse. Secondly, the vertebral compression occurs in the depth of the thoracic curvature, where the muscular action is greatest, in contrast to traumatic compression occurring in the lower thoracic and lumbar regions. Thirdly, the contractions of the muscles in the convulsions are both clonic and tonic, resulting in two types of force. Fourthly, many of the patients showed a predisposing dorsal kyphosis.

Prevention is the best method of treatment and is accomplished by placing the patient in bed, on his back, with hyperextension of the thoracic spine, before the convulsions are induced, and keeping him in that position throughout the treatment.

JOHN B. MCANENY, M.D.

Fractures of the Vertebrae during Metrazol Therapy. L. L. Turcen and J. A. Key. *J. Missouri M.A.* 37: 194-197, May, 1940.

Six cases of fracture of the spine occurred in a series of 20 patients in whom convulsions were induced by metrazol. These are reported briefly. It is believed that fractures of this type are produced by a severe longitudinal compression of the spine while the patient is in a position of opisthotonos and that the spine fractures in the midthoracic region because the normal dorsal curve is maintained and the midthoracic region is the area of greatest curvature. All of the 6 patients in whom fractures occurred were of the asthenic type. The fractures were relatively mild in character and in none was the deformity sufficient to warrant an attempt at correction by immobilizing in hyperextension, nor were there sufficient symptoms to make it necessary to keep the patients off their feet. In the more severe fractures accompanied by nerve root pains, a Taylor back brace was sufficient.

L. W. PAUL, M.D.

BLOOD AND LYMPH SYSTEMS

Follicular Lymphoblastoma (Giant Lymph Follicle Hyperplasia of Lymph Nodes and Spleen). A. H. Baggenstoss and F. J. Heck. *Am. J. M. Sc.* 200: 17-27, July, 1940.

The clinical and pathological entity variously called

"giant lymph follicle hyperplasia of lymph nodes and spleen," "giant follicular lymphadenopathy," or "follicular lymphoblastoma," generally begins insidiously with enlargement of lymph nodes unaccompanied by ill health.

The chief characteristics are (1) lymphadenopathy due to hyperplasia of the lymph follicle germinal centers, (2) splenomegaly due chiefly to the enormous enlargement of malpighian bodies, (3) absence of abnormal cells in the blood, (4) absence of anemia or cachexia, (5) tendency to serous effusions in pleural and peritoneal cavities, (6) absence of involvement of tonsils and lymphatic apparatus of gastro-intestinal tract, (7) tendency to lymphatic infiltration in the lacrimal gland, resulting in unilateral exophthalmos, and (8) multicentric origin throughout the body in the lymph follicles.

The most helpful signs in distinguishing follicular lymphoblastoma from inflammatory hyperplasia are the great numerical and dimensional increase in the follicles, the tendency of the follicles to fuse with each other, and the narrowing and obliteration of the lymphatic sinuses.

In cases in which a conclusion cannot be reached as to the differential diagnosis, observation and repeated biopsy would seem to be indicated.

It is generally agreed that follicular lymphoblastoma responds more readily to irradiation than does any other neoplastic disease of the lymph nodes. After repeated treatments resistance to irradiation increases until finally no effect is achieved. No permanent cures have as yet been recorded.

BENJAMIN COLEMAN, M.D.

Besnier-Boeck-Schaumann's Disease: The Chronic Epithelioid-Cell Infectious (Tuberculous) Reticulo-endotheliosis. S. J. Leitner. *Schweiz. med. Wchnschr.* 70: 411, 441, 461, May 11, 18, and 25, 1940.

For the so-called Besnier-Boeck-Schaumann's disease the author prefers the term chronic epithelioid-cell infectious (tuberculous) reticulo-endotheliosis, or more briefly epithelioid-cell reticulo-endotheliosis. The manifestations in the eye (Heerfordt's uveoparotitis), the skin (Boeck's sarcoid, lupus pernio, Darier-Roussy's sarcoid), the bones (ostitis cystoides of Jüngling), the lymph nodes (benign lymphogranulomatosis), the lungs (glandulo-pulmonary form), and other organs (spleen, liver, and bone marrow) are only different localizations of the same basic process. Limited localization is characteristic of almost every syndrome in this disease. The pathological anatomy is that of an epithelioid-cell reticulosis through an epithelioid granuloma, with little or no giant cell formation and secondary hyalinization and no caseation.

The etiology of this disease is still obscure. Some facts speak for a tuberculous etiology: the tuberculoid histologic structure, the occasional demonstration of bacilli in the stroma, the frequent positive animal inoculations and cultures, the positive complement fixation and flocculation reactions, and the transition

to caseating tuberculosis. The frequently negative tuberculin reaction is explained by advocates of the tuberculosis etiology as a positive anergy. Against tuberculosis is the frequent negative result of search for bacilli. Although cultures and animal inoculations with sputum, urine, blood, sternal puncture material, and lymph nodes were all negative in the cases reported here, the author inclines to believe the etiology to be generally if not always tuberculous.

The clinical picture varies with the localization, and is always characterized by chronicity and a benign course. In three cases reported with skin, eye, lymph node, lung, and apparently renal and splenic involvement the course ran for three to six years.

Five types of glandulopulmonary disease are differentiated by roentgen study; the hilar node type, the parahilar type, the fine-grain miliary type, the large-grain type, and the flat infiltrating form. The blood sedimentation was normal or slightly elevated. Eosinophilia and monocytosis were observed. One patient had leukopenia and thrombopenia, with a shift to the left of the myelocytes in the sternal marrow, but had no epithelioid cell hyperplasia. In this instance lymph node puncture proved diagnostic.

The value of protracted sanitarium care is questionable; on the other hand, short courses of climatic therapy, as well as arsenic, gold, tuberculin, sun or quartz light, weak doses of roentgen rays, and perhaps also mild stimulative treatment are useful. The study of epithelioid-cell reticulosis, affected as the disease is by the constitutional reactivity of the individual and the virulence of the infecting organism, is especially important because the disease, though not rare, is frequently unrecognized.

This is an excellent presentation of the author's views on the subject, and while conflicting opinions might be presented, the monograph is worth reading.

LEWIS G. JACOBS, M.D.

TECHNIC

Practical Applications of Body Section Roentgenography. S. Moore. *Am. J. Roentgenol.* **44**: 24-30, July, 1940.

The laminagraph is one of many types of apparatus designed to take x-ray pictures of thin, selective sections of tissue by dispersing shadows of overlying and underlying structures. Body section roentgenography disperses unwanted shadows, and also develops the minimum of density contrast in a thin layer of tissue.

Unwanted shadows eliminated by this method have been most frequent in the respiratory tract: for example, the bones about the paranasal sinuses, the ribs and sternum in the chest, and the spine in examination of the larynx. Among 372 chest examinations, some cavities and consolidations have been found which were missed by conventional methods.

Laminagrams are of little value in early acute disease in the lungs, in examination of the vault of the skull, intracranial tumors, or the sella turcica except for the floor of this structure. Nor has the method been of great value in study of the ribs, lumbar spine, or soft tissues, although aneurysms have been outlined. Laminagrams of paranasal sinuses have been very valuable, and their accuracy has been demonstrated on cadavers.

The method is of value also in retrobulbar neuritis of undetermined origin, and study of the axial portion of the skeleton is probably its ideal application, especially in the dorsal spine. The temporo-mandibular joint, the auditory canals, the first three cervical vertebrae, and the sacrum are favorable fields for study by this technic. Productive bone tumors of the appendicular skeleton might be studied to advantage by laminagrams.

S. M. ATKINS, M.D.

RADIOTHERAPY

MALIGNANT NEOPLASMS

Radium Needles in the Treatment of Carcinoma of the Cervix and Vagina. A. N. Arneson and H. Hauptman. *Southern M.J.* **33**: 286-291, March, 1940.

For the adequate treatment of carcinoma of the cervix both x-rays and radium are necessary. Intra-uterine radium application does not control carcinoma located more than 5 cm. from the cervical canal. External roentgen therapy increases the radiation in the parametrium, but, to obtain a greater percentage of cures, even higher doses are needed.

Needles 2 to 4 cm. long containing 2 to 4 mg. of radium, filtration 0.5 mm. gold, inserted lateral to the fundus, and anterior and posterior to the cervix, together with the intra-uterine tandem for five to seven days, serve to increase the radiation received by the parametrium. Post-irradiation recurrences are also

well treated by this interstitial application. Severe reactions and infections are not frequent complications of this form of treatment. Serious infection and ulceration are contraindications.

JOHN M. MILES, M.D.

Radiation Therapy in Carcinoma of the Fundus of the Uterus. C. L. Martin. *Southern M.J.* **33**: 135-142, February, 1940.

A hinged applicator is described to be used in the fundus of the uterus for the more adequate irradiation of uterine carcinoma. The applicator consists of an aluminum capsule 3.0 cm. in length, hinged at one end to a piece of soft wire 6.5 cm. long in such a manner that the capsule, which contains 6.25 mg. radium filtered by 1.0 mm. platinum, rotates in one plane. The advantage of the device is that, after the shape and size of the uterine cavity and carcinoma are determined,

the radium can be applied more accurately and uniformly than with the usual tandem applicator. The wires, in addition, hold the radium in place and maintain drainage through the cervical canal.

In practice five or six containers are left in place for five days, giving a total of 3,750 to 4,500 mg. hr., with an additional 24-hour application of a 75 mg. tandem capsule in the cervical canal and lower uterus. The applicators are used only when the uterus is enlarged. In a uterus of normal size two or three 25 mg. units in tandem are inserted in the uterine canal for three days, giving a total of 3,000-4,000 mg. hr. Curettage is done six to eight weeks after radium application and if malignant tissue is found operation is advised.

JOHN M. MILES, M.D.

Carcinoma of the Cervix before the Age of Twenty Years. A. W. Diddle. *Am. J. Cancer* 39: 207-210, June, 1940.

A single case is recorded of carcinoma of the cervix in a seventeen-year-old girl who had symptoms of two years' duration on admission and died three months later in spite of treatment: a total of 14,400 r in air to the pelvis through six ports (200 kv., 20 ma., and Thoraeus filter).

In a series of 505 cases of carcinoma of the cervix only 5 were in patients under twenty-five years of age. A review of the literature disclosed 18 cases in patients less than twenty years old. Five cases occurred before the age of fourteen. The impression was obtained that the prognosis of carcinoma of the cervix before the age of twenty is grave.

HAROLD O. PETERSON, M.D.

Important Aspects of Malignancies of the Skin and Mucous Membranes. Patricia H. Drant. *Pennsylvania M. J.* 43: 1405-1410, July, 1940.

The author confines her paper to a discussion of the diagnosis and treatment of precancerous and cancerous lesions of the vulva. She believes that vulvectomy should be done in all cases except where the condition is far advanced. In the advanced cases she says, "electrodesiccation and roentgen-ray may give a degree of comfort."

JOSEPH T. DANZER, M.D.

Carcinoma to the Spleen: Metastases. Paul H. Guttman. *California & West. Med.* 52: 156-158, April, 1940.

The author discusses the rarity of carcinoma of the spleen and the types of tumors which metastasize to the spleen. He reviews the literature and reports a case of splenic metastasis secondary to scirrhous carcinoma of the breast.

JAMES J. CLARK, M.D.

Roentgen Therapy of Cancer of Bladder. L. S. Goin. *Urol. & Cutan. Rev.* 44: 355-357, June, 1940.

The author makes a plea for bolder and more intelligent use of external irradiation in the treatment of inoperable cancer of the bladder. Four cases are presented.

JOHN G. MENVILLE, M.D.

Value of Pre-operative and Post-operative Supervoltage X-ray Therapy in Cancer of Prostate. R. L. Smith. *Urol. & Cutan. Rev.* 44: 377-379, June, 1940.

Supervoltage radiation is believed by the author to be superior to 200 kv. radiation. He also concludes that a combination of extremely high-voltage radiation and one-third of an erythema dose of lower voltage radiation seems to produce more rapid recession of diffuse superficial lesions.

JOHN G. MENVILLE, M.D.

Radiation Treatment of Testicular Tumors. D. D. Enfield. *Urol. & Cutan. Rev.* 44: 380-383, June, 1940.

A case of malignant tumor of the testicle is presented. The testicle was removed and approximately one month later post-operative irradiation was begun; 4,000 r divided among five fields were given. When irradiation was started no evidence of metastasis was noted, but in spite of 22,000 r units, metastases developed and the patient died. The author reviews the technic of irradiation in tumors of the testicle used by some of the larger clinics in the United States.

JOHN G. MENVILLE, M.D.

Treatment of Metastases. M. C. Tod. *Brit. J. Radiol.* 13: 163-171, May, 1940.

The effectiveness of the treatment of metastases depends somewhat on how the metastasis takes place. If it is possible to predict the direction of metastasis, as in cancer of the breast, some success is obtained by treating these areas surgically or radiologically before secondary deposits become apparent.

The method of therapy depends to some extent on what is likely to be accomplished, whether a cure or only palliation.

Regional therapy may be used. This involves delivering to the whole area of probable involvement a dose which will be lethal for the tumor, but will not exceed the general tolerance. This may be used for sensitive tumors which spread by the lymphatics. A detailed example is given for a seminoma testis.

For more resistant tumors, localized therapy should be used. Operation, if possible, should be done. This type of therapy is applicable to localized lymph nodes and localized areas of bony metastasis.

For palliation only, four methods are advised: localized therapy to single symptom-producing deposits, treatment aimed at restraining growth of resistant tumors, treatment of individual metastases as they

appear, and treatment directed to the relief of symptoms.

SYDNEY J. HAWLEY, M.D.

Progress Report from the Division of Cancer Control of the Department of Health of the Commonwealth of Pennsylvania. Stanley P. Reimann. *Pennsylvania M.J.* 43: 1141-1144, May, 1940.

The aim of the department of health of the State of Pennsylvania in making cancer a reportable disease is, first, to gather more information and second, to stimulate interest in tumors. That the report blanks have caused a good deal of discussion and criticism is admitted by the author and he believes that this is a good thing as it arouses interest.

A few of the findings and problems are set forth in this paper in interesting detail.

JOSEPH T. DANZER, M.D.

NON-MALIGNANT CONDITIONS

Our Experience with the Indirect Roentgen Therapy of Lichen ruber planus and Progressive Scleroderma. K. Halter and V. Lundt. *Strahlentherapie* 67: 625, 1940.

The author relates his experience in the x-ray treatment of 47 cases of lichen ruber planus and 8 cases of progressive scleroderma. Instead of treating the lesions proper he exposed the corresponding part of the spine, or in a case of generalized involvement the entire spine. The technic was as follows: 180 kv., 40 cm. FSD, 0.5 mm. Cu + 1.0 mm. Al, 10 × 15 cm. field size, 134 r (in air). This dose is repeated after two weeks and if necessary at monthly intervals up to six times. The results were very gratifying. It is suggested that arsenic medication preceding radiation therapy might further improve the results in lichen ruber planus. The patients with progressive scleroderma were definitely improved and in some the disease remained stationary after the treatment. It is suggested that the therapeutic effect takes place *via* the sympathetic nervous system.

ERNST A. POHLE, M.D., Ph.D.

Five Years of Radium Treatment of Hemangiomas. Roland Müller. *München. med. Wchnschr.* 87: 538-541 May 17, 1940.

The author reports his results in the treatment of hemangiomas with radium. He prefers contact application or application at a distance of 5 cm. from the skin, and only rarely inserts needles. These latter are mostly used for resistant or inaccessible lesions. The radioactive source may be radium or thorium X.

Of 144 cases treated, 134 were cured and 9 greatly improved. One patient showed no improvement. In only one case were there undesirable sequelae, and these were thought to be the result of infection rather than of the treatment.

LEWIS G. JACOBS, M.D.

Hemangioma of the Uterus Treated with Roentgen Rays. A. Y. Kevorkian. *New England J. Med.* 223: 1-3, July 4, 1940.

A woman was operated upon under the assumption that she had a fibroid tumor of the uterus. At operation, an hemangioma was found infiltrating the uterus. Following hysterectomy, a large recurrent tumor developed. This was treated by a series of six "high-voltage roentgen-ray treatments" of 400 r each, three anteriorly, and three posteriorly to the pelvis, at 40 cm. distance, with fields 30 × 30 cm., 0.5 mm. copper, and 1.0 mm. aluminum filtration. Two months later a similar series of roentgen treatments was given and again in three months a third series. A fourth series was given fifteen months after operation.

The tumor disappeared completely and there had been no recurrence after six years' observation. The irradiated skin of the buttocks and lower abdomen showed fibrosis, edema, and telangiectases.

JOHN McANENY, M.D.

Treatment of Corneal Ulcers with Emphasis on X-ray Therapy and the Use of Vitamins. M. Baird and G. E. Clay. *Southern M.J.* 33: 396-399, April, 1940.

X-ray therapy, the authors find, has been the most valuable single item in the treatment of all bacterially infected corneal ulcers. They have used it for this condition for six years. Diminution in edema and relief of pain, which is often dramatic, are the benefits listed. Perforation of the ulcer is prevented. The most spectacular results have occurred in pneumococcal ulcer, the prognosis of which is always grave.

From 80 to 100 r units are given at intervals of three to five days for a total of four to six treatments, unfiltered radiation being applied directly to the ulcerated area. Occasionally one or two treatments suffice. No untoward sequelae have been noted.

Other general and specific measures are discussed and the importance of vitamin A administration is emphasized. From 30,000 to 40,000 units of vitamin A are given orally every day.

JOHN M. MILES, M.D.

Chronic Sinus Infection in Children: Results with Roentgen Therapy. P. A. McLendon and R. R. Rathbone. *Southern M.J.* 33: 366-375, April, 1940.

Chronic sinus infection is common in children and may be either allergic, hyperplastic, polypoid, or purulent. Clinical findings include headaches, cough when lying down, sniffing, enlarged cervical lymph nodes, otitis media, chronic bronchitis, malnutrition, lassitude, etc. Hyperplastic and allergic sinus disease as a rule cannot be differentiated roentgenologically.

Roentgen examination of the sinuses is not complete without a lateral view to show the posterior nasal space. This view gives information as to adenoid enlargement and retropharyngeal adenitis. A chest plate, if cough is present, may show a so-called sino-bronchitis.

For therapy the authors use 125 kv., 5 ma., 12 in. distance, 3 mm. aluminum filter, 10×10 cm. portals, anterior and right and left lateral positions. One area is treated every other day (75 r in children under one year to 120 r in those over five years) for a total of six treatments in a two-week period. Large areas are treated, the eyes being protected so that the sinuses, tonsils, mastoids, and entire pharynx are irradiated. When cough is prominent 75 r is given to the chest at two-day intervals for two treatments.

Seventy per cent improvement is claimed in 68 patients, or 80 per cent of the total treated in a series which has been followed sufficiently long to evaluate the results. Cough has subsided within a week of the first treatment and entirely disappeared in most instances within a month.

Improvement is evidenced clinically by smaller amount of purulent drainage in subsequent attacks of rhinitis and improvement in general symptoms of malaise, lassitude, etc. In allergic cases the improvement is probably due to shrinkage of the tissue allowing better drainage. Roentgen improvement does not coincide with clinical improvement.

JOHN M. MILES, M.D.

TECHNIC

Physical Investigation of the Radiation from a Low-voltage X-ray Tube (Cautery Technique). L. F. Lamerton. *Brit. J. Radiol.* **13**: 136-146, April, 1940.

This study was made with a Philips "Metalix" therapy apparatus. The focal spot was found to be irregular in shape, with a bright center area of 1.2×1.5 mm.

In a study of the spectrum by a Seemann spectrograph, the L_{γ_1} line of tungsten at 1,096 X. U. and possibly the L_{β_2} at 1,242 X. U. were identified. The short wave cut-off occurred at about 280 X. U.

Absorption curves were obtained for unfiltered and filtered beams. The first half-value layer for unfiltered radiation was 0.3 mm. Al; the second 0.6 mm. Al. With 1.0 mm. Al filter the first half-value layer was 1.0 mm. Al; with 2.5 mm. Al filter, the first half-value layer was 1.61 mm. Al. It was found that the air appreciably absorbs the unfiltered radiation. Absorption curves in water, horse serum, and sheep blood were obtained. The curves for these latter substances are not appreciably different from that of water. Four millimeters of water absorbs 50 per cent of the intensity.

Measurement of the dosage rate in air required a special chamber, because of the marked absorption by air. Such a chamber is described; 7,610 r/m were delivered at a focal skin distance of 2.0 cm., the shortest possible distance. The distribution is not symmetrical about the central axis of the beam.

Measurements were made of the exposure received

by the operator. With no tube filter and no applicator the operator might receive 0.1 r on his hands per 6,000 r treatment.

The energy distribution in the spectrum is deduced from an analysis of the absorption curve in aluminum.

SYDNEY J. HAWLEY, M.D.

A Model Head and Dose Finder. F. W. Spiers. *Brit. J. Radiol.* **13**: 147-148, April, 1940.

A model of a head made up of transparent cross-sections and a localizing system of two light beams are described. The apparatus is useful in finding the dosage administered in various parts of the head, particularly in the oral cavity, when multiple beams are used.

SYDNEY J. HAWLEY, M.D.

A Rotary Shutter for X-rays. H. E. Seemann and W. C. Vaeth. *Brit. J. Radiol.* **13**: 183-184, May, 1940.

The construction of a shutter made with a rotating disc is described. It is so constructed that all parts of the beam are exposed for the same length of time.

SYDNEY J. HAWLEY, M.D.

Measurements with "Pendulum" Irradiation. M. Bender and A. Kohler. *Strahlentherapie* **67**: 600, 1940.

In this second communication the authors relate the results of additional measurements undertaken with "pendulum radiation." They found a definite relationship between depth dose and width of the field, the pendulum angle, the position of the pendulum center, and the focal surface distance. A variety of phantoms were used; if the phantom's cross-section approached a circle the theoretical calculations were in good agreement with the experimental results. The depth dose curves are shown in 8 diagrams.

ERNST A. POHLE, M.D., Ph.D.

Use of Beta Ray of Radium Applicator. Description of Method and Results Obtained in Superficial Lesions of the Eye. C. F. Burnam and W. Neill, Jr. *Southern M.J.* **33**: 279-284, March, 1940.

A spinal applicator is described containing glass bulbs filled with 300 to 500 mc. of radium. This is used, with no added filtration, in the treatment of a variety of superficial inflammatory and neoplastic diseases of the conjunctiva, sclera, cornea, and skin, especially when intense local irradiation is advisable and protection of adjacent structures is important.

Reports are included of corneal scars, vernal catarrh, melano-epithelioma, pigmented mole, and keloids in the eyes. The exposure time varies from a few seconds to a few minutes. Good results are reported.

JOHN M. MILES, M.D.

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